Fishery Data Series No. 14-55

Production, Escapement, and Juvenile Tagging of Chilkat River Chinook Salmon in 2011

by

Richard S. Chapell

December 2014

Alaska Department of Fish and Game Divisions of Sport Fish and Commercial Fisheries

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Weights and measures (metric)

centimeter	cm
deciliter	dL
gram	g
hectare	ha
kilogram	kg
kilometer	km
liter	L
meter	m
milliliter	mL
millimeter	mm

Weights and measures (English)

cubic feet per second	ft^3/s
foot	ft
gallon	gal
inch	in
mile	mi
nautical mile	nmi
ounce	oz
pound	lb
quart	qt
yard	yd

Time and temperature

day	d
degrees Celsius	°C
degrees Fahrenheit	°F
degrees kelvin	K
hour	h
minute	min
second	s

Physics and chemistry

all atomic symbols	
alternating current	AC
ampere	A
calorie	cal
direct current	DC
hertz	Hz
horsepower	hp
hydrogen ion activity (negative log of)	pH
parts per million	ppm
parts per thousand	ppt, ‰
volts	V
watts	W

General

Alaska Administrative Code	AAC
all commonly accepted abbreviations	e.g., Mr., Mrs., AM, PM, etc.
all commonly accepted professional titles	e.g., Dr., Ph.D., R.N., etc.
at	@
compass directions:	
east	E
north	N
south	S
west	W
copyright	©
corporate suffixes:	
Company	Co.
Corporation	Corp.
Incorporated	Inc.
Limited	Ltd.
District of Columbia	D.C.
et alii (and others)	et al.
et cetera (and so forth)	etc.
exempli gratia (for example)	e.g.
Federal Information Code	FIC
id est (that is)	i.e.
latitude or longitude	lat or long
monetary symbols (U.S.)	$, ¢
months (tables and figures): first three letters	Jan,...,Dec
registered trademark	®
trademark	™
United States (adjective)	U.S.
United States of America (noun)	USA
U.S.C.	United States Code
U.S. state	use two-letter abbreviations (e.g., AK, WA)

Mathematics, statistics

all standard mathematical signs, symbols and abbreviations	
alternate hypothesis	H_A
base of natural logarithm	*e*
catch per unit effort	CPUE
coefficient of variation	CV
common test statistics	(F, t, χ^2, etc.)
confidence interval	CI
correlation coefficient (multiple)	R
correlation coefficient (simple)	r
covariance	cov
degree (angular)	°
degrees of freedom	df
expected value	*E*
greater than	$>$
greater than or equal to	$\geq$
harvest per unit effort	HPUE
less than	$<$
less than or equal to	$\leq$
logarithm (natural)	ln
logarithm (base 10)	log
logarithm (specify base)	$\log_{2,}$ etc.
minute (angular)	'
not significant	NS
null hypothesis	H_O
percent	%
probability	P
probability of a type I error (rejection of the null hypothesis when true)	α
probability of a type II error (acceptance of the null hypothesis when false)	β
second (angular)	"
standard deviation	SD
standard error	SE
variance	
population	Var
sample	var

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ABSTRACT

In 2011, angler effort and harvest of Chilkat River Chinook salmon *Oncorhynchus tshawytscha* in the spring Haines marine boat sport fishery were estimated using an onsite creel survey. An estimated 8,592 angler-h (SE = 471) of salmon effort yielded a harvest of 217 (SE = 16) large Chinook salmon (≥28 in TL), of which 174 (SE = 13) were wild, mature fish.

The 2011 Chinook salmon inriver run was estimated with a 2 event mark–recapture experiment. Between June 9 and August 27, a total of 343 Chinook salmon were marked and released in the lower Chilkat River during the first event: 216 large (age 1.3 and older), 95 medium (age 1.2), and 32 small (age 1.1). Event 2 sampling occurred in spawning tributaries, where 569 large, 199 medium, and 1 small Chinook salmon were captured and examined. Of the captured fish, 43 large, 17 medium, and 0 small fish were marked. An estimated 4,341 (SE = 480) Chinook salmon, of which 2,688 (SE = 368) were large, immigrated into the Chilkat River.

Juvenile abundance and marine harvest of Chinook salmon originating from brood year 2004 were estimated through coded wire tag recoveries. In fall 2005, an estimated 529,700 (SE = 70,150) brood year 2004 parr reared in the Chilkat River drainage. Overwinter survival was estimated at 23.4% (SE = 4.6%), and an estimated 122,800 (SE = 19,820) smolts emigrated in 2006. An estimated 434 (SE = 112) brood year 2004 fish were harvested in marine fisheries between 2007 and 2011.

Juvenile Chinook salmon from brood year 2010 (26,360 parr in fall 2011 and 3,175 smolts in spring 2012), were captured in the Chilkat River drainage and released with coded wire tags and clipped adipose fins.

Key words: Chinook salmon, Oncorhynchus tshawytscha, Chilkat River, age stratified, mark-recapture, escapement, angler effort, creel survey, harvest, angler-h, salmon-h, Haines marine sport fishery, coded wire tags, marine survival, total return, length-at-age.

INTRODUCTION

The Chilkat River drainage produces the third or fourth largest run of Chinook salmon *Oncorhynchus tshawytscha* in Southeast Alaska (McPherson et al. 2003). This large glacial system has its headwaters in British Columbia, Canada, flows through rugged, dissected, mountainous terrain, and terminates in Chilkat Inlet near Haines, Alaska (Figure 1). The mainstem and major tributaries comprise approximately 350 km of river channel in a watershed covering about 2,600 km² (Bugliosi 1988) of which 867.6 km^2 are considered accessible to anadromous fish (Ericksen and McPherson 2004). Past coded wire tag (CWT) studies have shown that Chilkat River Chinook salmon rear primarily in the inside waters of northern Southeast Alaska, and less so in the Gulf of Alaska, Prince William Sound, and Kachemak Bay (Pahlke 1991; Johnson et al. 1993; Ericksen 1996, 1999; Ericksen and Chapell 2006; Chapell 2009, 2010, 2012, 2013a, 2013b). Most marine harvest of Chilkat River Chinook salmon occurs in commercial troll and gillnet fisheries in northern Southeast Alaska, in the sport fishery near Haines, and in the Chilkat Inlet subsistence fishery. In the Chilkat River, some Chinook salmon are harvested in the subsistence fishery, but sport and commercial fishing are not allowed.

A creel survey has been used to estimate Chinook salmon harvest in the Haines marine boat sport fishery since 1984. Fishery access points are Letnikof Cove, Haines Small Boat Harbor, and Chilkat State Park (Figure 1). The harvest in this fishery peaked at over 1,600 Chinook salmon in 1985 and 1986 (Table 1). The fishery in Haines contributes significantly to the local economy, supports a salmon derby, and is popular with both Haines residents and anglers from other areas (Bethers 1986; Jones & Stokes 1991).

Beginning in 1981, the Alaska Department of Fish and Game (ADF&G) Division of Sport Fish (SF) began monitoring Chilkat River Chinook salmon escapement trends using aerial index survey counts in Stonehouse and Big Boulder creeks (Figure 1; Kissner 1982). These creeks were selected as index areas because they were the only clearwater spawning areas that could provide standardized, consistent survey counts. These index areas were used in a regionwide program to monitor Chinook salmon escapements in Southeast Alaska (Pahlke 1992).

Concern about the Chilkat River Chinook salmon population developed when aerial survey counts declined in 1985 and 1986, coincident with increasing marine harvests of Chinook salmon in commercial troll, commercial drift gillnet, and sport fisheries in the area. In 1987, ADF&G began to restrict fisheries in upper Lynn Canal, and the spring sport Chinook salmon fishery near Haines was closed entirely in 1991 and 1992. The Haines King Salmon Derby did not occur from 1988 through 1994.

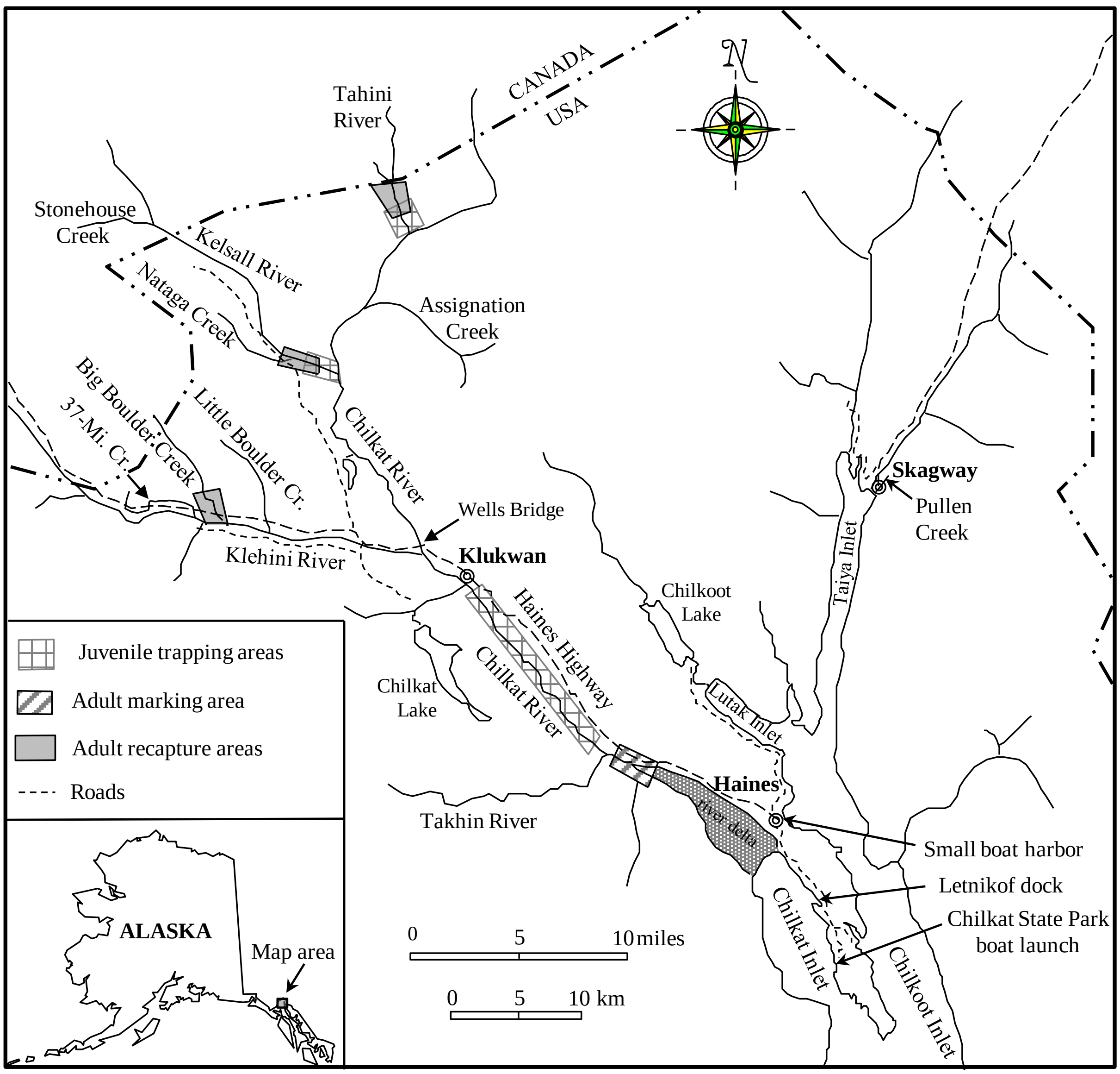

Figure 1.–Location of adult and juvenile Chinook salmon capture, sampling, and release sites near Haines and Skagway in Southeast Alaska, 2011.

Table 1.–Estimated angler effort, and large (≥28 inch TL) Chinook salmon catch and harvest in the Haines marine sport fishery for similar sample periods, 1984–2011 in Southeast Alaska.

		Effort				Large (≥28 inch TL) fish				
Year	Survey dates	Angler-h	SE	Salmon-h	SE	Catch	SE	Harvest	SE	CPUE[a]
1984[b]	May 6–June 30	10,253	[c]	9,855	[c]	1,072	[c]	1,072	[c]	0.109
1985[d]	April 15–July 15	21,598	[c]	20,582	[c]	1,705	[c]	1,696	[c]	0.083
1986[e]	April 14–July 13	33,857	[c]	32,533	[c]	1,659	[c]	1,638	[c]	0.051
1987[f]	April 20–July 12	26,621	2,557	22,848	2,191	1,094	189	1,094	189	0.048
1988[g]	April 11–July 10	36,222	3,553	32,723	3,476	505	103	481	101	0.015
1989[h]	April 24–June 25	10,526	999	9,363	922	237	42	235	42	0.025
1990[i]	April 23–June 21	[i]	[i]	11,972	1,169	248	60	241	57	0.021
1991	Chinook salmon sport fishery was closed.									
1992	Chinook salmon sport fishery was closed.									
1993[j]	April 26–July 18	11,919	1,559	9,069	1,479	349	63	314	55	0.038
1994[k]	May 09–July 03	9,726	723	7,682	597	269	41	220	32	0.035
1995[l]	May 08–July 02	9,457	501	8,606	483	255	42	228	41	0.030
1996[m]	May 06–June 30	10,082	880	9,596	866	367	43	354	41	0.038
1997[n]	May 12–June 29	9,432	861	8,758	697	381	46	381	46	0.044
1998[o]	May 11–June 28	8,200	811	7,546	747	222	60	215	56	0.029
1999[p]	May 10–June 27	6,206	736	6,097	734	184	24	184	24	0.030
2000[q]	May 08–June 25	4,428	607	4,043	532	103	34	49	12	0.025
2001[r]	May 07–June 24	5,299	815	5,107	804	199	26	185	26	0.039
2002[s]	May 06–June 30	7,770	636	7,566	634	343	40	337	40	0.045
2003[t]	May 05–June 29	10,651	596	10,055	578	405	40	404	40	0.040
2004[u]	May 10–June 27	12,761	763	12,518	744	413	46	403	44	0.033
2005[v]	May 09–June 26	12,641	1,239	12,287	1,216	260	31	252	31	0.021
2006[w]	May 08–June 25	8,172	610	7,869	558	176	15	165	13	0.022
2007[x]	May 07–June 24	7,411	725	7,223	690	285	43	285	43	0.039
2008[y,z]	May 05–June 22	1,211	177	1,132	167	27	11	27	11	0.024
2009[aa]	May 04–June 21	7,405	534	7,267	520	145	12	143	12	0.020
2010[ab]	May 10–June 27	7,983	523	7,901	510	222	25	219	25	0.028
2011	May 09–June 26	8,743	478	8,592	471	217	16	217	16	0.025
1984–1987 average		23,082		21,455		1,383		1,375		0.073
1988–2010 average		9,875		9,256		266		253		0.031

[a] Catch of large Chinook salmon per salmon h of effort.
[b] From Neimark (1985).
[c] Estimates of variance were not provided until 1987.
[d] From Mecum and Suchanek (1986).
[e] From Mecum and Suchanek (1987).
[f] From Bingham et al. (1988).
[g] From Suchanek and Bingham (1989).
[h] From Suchanek and Bingham (1990).
[i] From Suchanek and Bingham (1991); no estimate of the total angler effort and harvest was provided.
[j] From Ericksen (1994).
[k] From Ericksen (1995).
[l] From Ericksen (1996).
[m] From Ericksen (1997).
[n] From Ericksen (1998).
[o] From Ericksen (1999).
[p] From Ericksen (2000).
[q] From Ericksen (2001).
[r] From Ericksen (2002 a).
[s] From Ericksen (2003).
[t] From Ericksen (2004).
[u] From Ericksen (2005).
[v] From Ericksen and Chapell (2006).
[w] From Chapell (2009).
[x] From Chapell (2010).
[y] From Chapell (2012).
[z] Chilkat Inlet was closed to Chinook salmon retention and the Haines King Salmon Derby was cancelled.
[aa] From Chapell (2013a).
[ab] From Chapell (2013b).

Because of these concerns, SF conducted a coded-wire-tagging program on wild juvenile Chinook salmon in 1989 and 1990 in the Chilkat River to identify migratory patterns and to estimate contributions to sport and commercial fisheries (Pahlke et al. 1990; Pahlke 1991). The division also conducted radiotelemetry and mark-recapture experiments in 1991, 1992, and in 2005 to estimate spawning distribution and the inriver run of large (age 1.3 and older) Chilkat River Chinook salmon. Most Chinook salmon spawned in 2 major tributaries of the Chilkat River, the Kelsall and Tahini rivers, and immature fish were primarily harvested in the inside waters of Southeast Alaska (Johnson et al. 1992, 1993; Ericksen 1996, 1999; Ericksen and Chapell 2006; Chapell 2009, 2010, 2012, 2013a, 2013b). The Division of Sport Fish has continued annual mark-recapture experiments to estimate the inriver run since 1991 (Johnson et al. 1992, 1993; Johnson 1994; Ericksen 1995–2001, 2002a, 2003–2005; Ericksen and Chapell 2006; Chapell 2009, 2010, 2012, 2013a, 2013b).

In 2000, SF began to mark Chilkat River Chinook salmon smolts with CWTs and adipose fin clips each spring to estimate smolt abundance and marine harvest. During the first year, SF tagged 1,996 smolts, which was fewer than desired (Ericksen 2002a). To increase the number of CWT'd Chilkat River Chinook salmon, SF began tagging juvenile Chinook salmon (parr) beginning in fall 2000 (Ericksen 2002a).

To increase the sample size of CWT detections in the Chilkat River by brood year (BY) and by fall or spring marking event without sacrificing female fish, a nonlethal CWT marking and detection method was used for the first time on this project starting with BY 2001. In spring 2003, Chinook salmon smolts were released with a second CWT implanted in the muscle tissue beneath the dorsal fin. A handheld wand scanner was used on returning adult fish to detect the second CWT under the dorsal fin. In nonlethal sampling, the presence or absence of the second CWT, combined with the age as determined from scale samples, identified adipose-clipped fish as marked in the fall or spring of a certain year. An added benefit of marking juveniles both as parr and smolts was that freshwater overwinter survival could be estimated.

ADF&G adopted a Chilkat River biological escapement goal (BEG) of 1,750 to 3,500 large (3 ocean age and older) Chinook salmon in January 2003 (Ericksen and McPherson 2004). This BEG formed the basis of the *Lynn Canal and Chilkat River King Salmon Fishery Management Plan* (5AAC 33.384) that was adopted by the Alaska Board of Fisheries in February 2003. The management plan specifies an inriver run goal range of 1,850 to 3,600 large Chinook salmon, as estimated at the adult marking area by the department's annual mark-recapture study (Figure 1). The difference between the management plan inriver run goal range and the BEG range allows for subsistence harvest of 100 large fish between the adult marking area and the spawning grounds. Since the adoption of the BEG and the management plan, inriver run estimates have ranged from 1,438 to 5,631 large Chinook salmon (Ericksen 2004, 2005; Ericksen and Chapell 2006; Chapell 2009, 2010, 2012, 2013a, 2013b).

In 2008, **s**ibling survival rates were used to project an inriver run below the lower end of the management plan goal range. As prescribed in the management plan, retention of Chinook salmon by sport anglers was prohibited in Chilkat Inlet through June 30, and commercial gillnets were prohibited in Chilkat Inlet through statistical week 27 (Figure 1). The Haines Sportsman's Association cancelled the 2008 Haines King Salmon Derby.

This report describes the methods and results of the Haines area marine Chinook salmon creel survey in 2011, the inriver adult Chinook salmon mark-recapture study in 2011, the tagging of juvenile Chinook salmon from BY 2010 in fall 2011 and spring 2012, and the smolt production and harvest of BY 2004 Chinook salmon. The long-term goal of these studies is to refine maximum harvest guidelines for Chilkat River Chinook salmon in accordance with sustained yield management.

OBJECTIVES

Research objectives were to estimate:

1. the inriver run of Chinook salmon into the Chilkat River in 2011;
2. the age, sex, and length compositions of the inriver run of large Chinook salmon in the Chilkat River in 2011;
3. the harvest of wild mature Chinook salmon in the Haines spring marine boat sport fishery from May 9 to June 26, 2011;
4. the mean length of Chinook salmon parr rearing in the Chilkat River drainage during fall 2011;
5. the mean length of Chinook salmon smolts rearing in the Chilkat River drainage during spring 2012;
6. the smolt abundance of Chilkat River Chinook salmon in 2006 (brood year 2004); and
7. the marine harvest of Chilkat River Chinook salmon from brood year 2004.

METHODS

INRIVER RUN ESTIMATE

A stratified mark-recapture experiment was used to estimate the inriver abundance of Chilkat River Chinook salmon in 2011. This estimate was germane to the time of marking at the event 1 site (Figure 1). The 2011 Chinook salmon escapement to the spawning grounds was estimated by subtracting reported Chilkat River subsistence fishery removals, which occurred primarily upstream of the marking site.

Event 1 - Marking

Gillnets 21.3-m long and 3.0-m deep (70 ft × 10 ft) were drifted daily in the lower Chilkat River from June 9 through July 24, 2011. The gillnets consisted of 2 equal-length panels: one of 17.1-cm (6.75 inch) and the other of 20.3-cm (8.0 inch) stretch measured nylon mesh. Forty three (43) drifts were completed between 0600 and 1400 hours each day. Fishing was conducted from a 5.5-m (18 ft) boat in 6 adjoining 0.5-km sections, which were marked along a 3-km section of river (Figure 2). This area was about 100-m wide and 2- to 3-m deep. The 43 drifts took about 6 h to complete when fish were not captured, and continued uninterrupted from area to area. If a (0.5 km) drift was prematurely terminated because a fish was caught, or if the net became entangled or drifted into shallow water, the terminated drift was resumed and completed before a new drift was started.

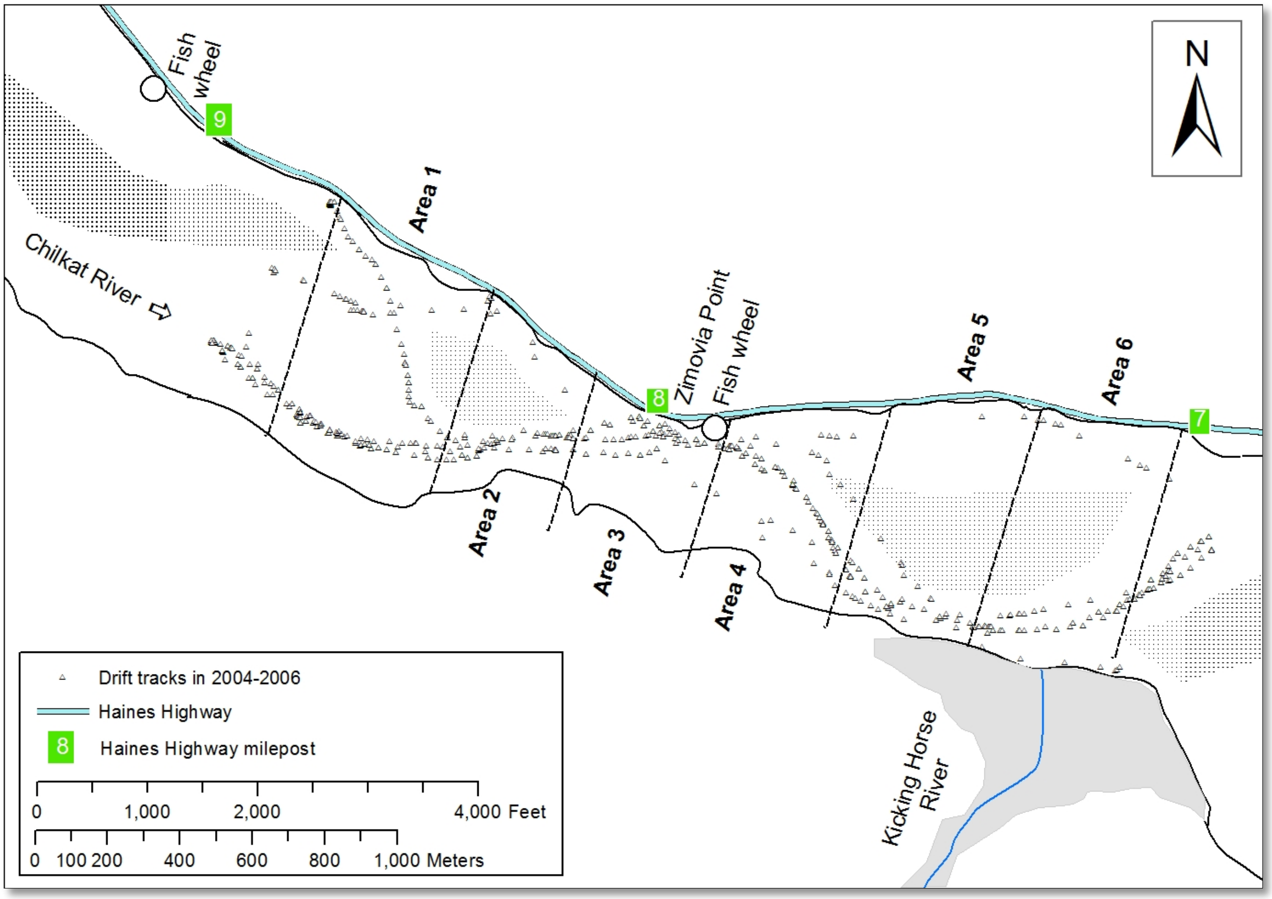

Figure 2.–Event 1 fish wheel locations and typical drift gill net paths in the lower Chilkat River, 2011 in Southeast Alaska,

Two 3-basket aluminum fish wheels were operated by ADF&G Division of Commercial Fisheries (CF) to monitor escapement of sockeye *O. nerka*, coho *O. kisutch*, and chum salmon *O. keta* from June 7 to October 11, 2011; incidentally captured Chinook salmon were also marked. One fish wheel was operated adjacent to Haines Highway milepost (MP) 9, and the other about 1,800 m downstream (Figure 2). The fish wheels were located along the east bank of the river (river left, looking downstream) where the main flow was constrained primarily to one side of the floodplain. Fish wheels operated continuously except for maintenance. The amount of time each fish wheel was stopped for maintenance was recorded each day. Water depth and temperature were recorded at a fixed gauge near MP 8 at 0900 hours each day.

Captured Chinook salmon were placed in a water-filled tagging box (see Figure 3 in Johnson 1994), measured to the nearest 5 mm mideye-to-fork (MEF), sampled for scales, and visually classified by sex. Fish ≥660 mm MEF were designated as large, fish ≥440 and <660 mm MEF as medium, and fish <440 mm MEF as small. All Chinook salmon were inspected for missing adipose fins.

All fish with missing adipose fins were scanned with a handheld wand CWT detector in the head area for a CWT, and in the area at the base of the dorsal fin for a second CWT. Heads were removed from all medium and small fish with missing adipose fins. Heads were removed from large fish with missing adipose fins only if no head CWT was detected, to verify tag loss. Collected heads were marked with individually numbered cinch straps and sent to the CF Mark, Tag, and Age Laboratory (Tag Lab) in Juneau for CWT recovery and decoding.

All healthy medium and large Chinook salmon (≥440 mm MEF) not sacrificed for CWT recovery were marked with a uniquely numbered spaghetti tag threaded over a solid plastic core, which was sewn through the bones near the base of the dorsal fin. Healthy small fish (<440 mm MEF) not sacrificed for CWT recovery were marked with a uniquely numbered T-bar anchor tag instead of a spaghetti tag. To minimize bias due to handling effects, unhealthy fish (e.g., lethargic or bleeding from the gills) were released untagged.

All tagged fish were given a 6-mm (¼ inch) hole punch in the upper edge of the left operculum (ULOP) as a secondary mark. Fish captured and tagged in gillnets were also marked by removing the left axillary appendage (LAA). This tertiary mark identified the event 1 capture gear (fish wheel or gillnet) in the event of primary tag loss.

The scale sampling procedure was to remove 5 scales from the left side of each sampled fish (right side if left side scales were missing or regenerated as determined by visual inspection) along a line 2 scale rows above the lateral line between the posterior insertion of the dorsal fin and anterior insertion of the anal fin. A triacetate impression of the scales (30 s at 10,240 kg/cm^2, or 3,500 lb/in^2, at a temperature of 97°C) was used to determine age by counting the scale annuli (Olsen 1992). When scale aging results were available postseason, each fish was reclassified as large, medium, or small using ocean age, rather than length, as criteria: fish with 3 or more ocean years of residence were classified as large, those with 2 ocean years as medium, and those with 1 ocean year as small. Any fish whose scales could not be aged was classified by length as described above.

Event 2 – Recapture

During the recapture event, Chinook salmon were captured in spawning tributaries using gillnets, dip nets, snagging gear, hands, or spears. The Kelsall River, including Nataga Creek and the Tahini River, were each sampled by a 2-person crew 5 d/wk (Monday through Friday) during August 2–September 2, 2011 (Figure 1). Klehini River tributaries - Big Boulder Creek, Little Boulder Creek, and 37-Mile Creek - were also sampled about every 5 days during the same period.

All captured Chinook salmon were inspected for marks and missing adipose fins, visually classified by sex, measured to the nearest 5 mm MEF, and sampled for scales as described in event 1 methods. Duplicate sampling was prevented by punching a hole in the lower edge of the left operculum (LLOP) of all captured fish.

As in event 1, all fish with missing adipose fins were scanned with a handheld wand CWT detector. Heads were removed from all medium and small fish with missing adipose fins. Heads were only removed from large fish in postspawning condition. Collected heads were marked with individually numbered cinch straps and sent to the CF Tag Laboratory in Juneau for CWT recovery and decoding.

The validity of the mark-recapture experiment rests on several assumptions (Seber 1982):

(a) every fish has an equal probability of being marked during event 1, or every fish has an equal probability of being captured in event 2, or marked fish mix completely with unmarked fish;

(b) recruitment and “death” (emigration) do not occur between sampling events;

(c) marking does not affect catchability (or mortality) of the fish;

(d) fish do not lose marks between sample events;

(e) all recovered marks are reported; and

(f) duplicate sampling does not occur.

The validity of assumption (a) was tested through a series of hypothesis tests (all at $\alpha = 0.1$). First, a contingency table (χ^2 statistic) was used to test the hypothesis that fish sampled at different spawning tributaries were marked at the same rate. Also, a contingency table was used to test the hypothesis that fish marked at different times in the run (e.g., early vs. late) were recaptured at the same rate.

The possibility of size-selective sampling was investigated because assumption (a) could be violated if the sampling rate varied by size of the fish. The null hypothesis that fish of different sizes were captured with equal probability during the first and second sampling events was tested using Kolmogorov-Smirnov (K-S) two-sample tests (Conover 1980) to compare size distributions in 3 ways:

(a) fish marked in event 1 versus marked fish recaptured in event 2 (M vs. R),

(b) all fish captured in event 2 versus marked fish recaptured in event 2 (C vs. R), and

(c) fish marked in event 1 versus all fish captured in event 2 (M vs. C).

K-S test results were evaluated using the protocol in Appendix A1, which indicated a Case II, where event 1 (combined fish wheel and drift gillnet captures) was not size selective but event 2 (spawning ground captures) was selective. The inriver run was therefore calculated using an unstratified Chapman’s modified Petersen estimator for a closed population (Seber 1982):

$$\hat{N} = \frac{(n_1 + 1)(n_2 + 1)}{(m_2 + 1)} - 1 \tag{1}$$

$$var[\hat{N}] = \frac{(n_1 + 1)(n_2 + 1)(n_1 - m_2)(n_2 - m_2)}{(m_2 + 1)^2 (m_2 + 2)} \tag{2}$$

where n_1 is the number of Chinook salmon marked in the lower river, n_2 is the number examined on the spawning grounds, and m_2 is the subset of n_2 that had been marked in the lower river.

The remaining Seber (1982) assumptions are considered in the *Discussion* section of this report.

Age, Sex, and Length Composition of the Inriver Run

Age and sex composition estimates can be biased due to sampling methods. Fish wheels are usually selective for smaller fish and males, while the gillnet mesh sizes used in this project are selective for larger fish (Ericksen 1995–2005; Ericksen and Chapell 2006; Chapell 2009, 2010, 2012, 2013a, 2013b). Carcass surveys are known to be sex selective in some situations (Pahlke et al. 1996; McPherson et al. 1997; Zhou 2002; Miyakoshi et al. 2003). In addition, significant variation in age compositions between spawning areas can bias composition estimates for the entire drainage when sampling is not proportional to abundance. Sex determination is more difficult early in the season while marking fish in the lower river (Ericksen 1995–2005).

Due to the biases stated above, age compositions were tabulated separately for fish caught in the lower river by gillnet and fish wheels (event 1), and in each sampled tributary (event 2). Standard sample summary statistics (Thompson 2002) were used to calculate age and sex composition, mean length-at-age, and their variances by event 1 gear type and by event 2 tributary.

Because the K-S tests of size distributions indicated that capture probability was not biased by fish size in event 1, pooled event 1 data were used to estimate the age composition of the inriver run by:

$$\hat{p}_a = \frac{n_a}{n} \tag{3}$$

$$var[\hat{p}_a] = \frac{\hat{p}_a\ (1-\hat{p}_a)}{n-1} \tag{4}$$

where p_a is the proportion of age class a fish, n_a is the number of age class a fish in the sample, and n is the number of fish in the sample. The inriver abundance of age a fish was estimated by:

$$\hat{N}_a = \hat{N}\ \hat{p}_a \tag{5}$$

$$\begin{aligned} var[\hat{N}_a] = {} & var[\hat{p}_a]\hat{N}^2 + \\ & var[\hat{N}]\hat{p}_a{}^2 - var[\hat{p}_a]var[\hat{N}] \end{aligned} \tag{6}$$

The abundance estimate of large fish (age-1.3 and older fish) was calculated in the same way using equations 3 through 6 with the proportion $\hat{p}_a$ being that of age-1.3 and older fish.

Contingency table analysis (χ^2 test) was used to detect sex-selective sampling in the first and second sampling events, using the null hypothesis that the probability that a sampled fish is male or female is independent of sampling in 3 comparisons, similar to comparisons of length distributions:

(a) fish marked in event 1 versus those recaptured in event 2 (M vs. R),

(b) all fish captured in event 2 versus marked fish recaptured in event 2 (C vs. R), and

(c) fish marked in event 1 versus all fish captured in event 2 (M vs. C).

Evaluation of the sex composition χ^2 test results using protocols in Appendix A1, presented later, indicated that event 1 was not sex selective but event 2 was selective, so event 1 data were used to estimate sex composition by age:

$$\hat{p}_s = \frac{n_s}{n} \tag{7}$$

$$var[\hat{p}_s] = \frac{\hat{p}_s\ (1-\hat{p}_s)}{n-1} \tag{8}$$

where p_s is the proportion of fish of sex *s*, n_s is the number of fish in the sample of sex *s*, and *n* is the number of sex *s* fish in the sample.

TERMINAL HARVEST

2011 Haines Marine Sport Fishery Harvest

A stratified two-stage direct expansion creel survey was used to estimate the harvest of Chinook salmon in the Haines marine boat sport fishery. Spatial stratification was by sample site. Temporal stratification included 7-day (weekly) periods at a high-use site, and 14-day (biweekly) periods at a low-use site. Separate temporal strata, derby and nonderby, were created for the biweek that included the five days of the *Haines King Salmon Derby*, May 28–30 and June 4–5. A third rarely used site was sampled only during a stratum of the 5 derby days. Each fishing day was defined as starting at 0800 hours and ending at civil twilight, which ranged from 2236 to 2351 hours over the seven weeks of the survey. Midday was defined as the time midway between 0800 hours and civil twilight. Sampling at each site had days as primary sampling units and boat-parties as secondary units.

The 3 sample sites were Letnikof Dock, Haines Small Boat Harbor, and Chilkat State Park boat launch (Figure 1). Prior surveys indicated that during 2001–2007 and 2009–2010, anglers landing their catch at the high-use Letnikof Dock site accounted for 59–86% of the total harvest of Chinook salmon, the low-use Small Boat Harbor site 12–39%, the Chilkat State Park boat launch 1–5%.

The rare use trend at the Chilkat State Park boat launch site prompted that site to be surveyed less frequently after 2008. In 1993–2008, Chilkat State Park was sampled as 1 of 2 low-use harbors, but often with a delayed start date relative to the Small Boat Harbor (Ericksen 1994–2005, Ericksen and Chapell 2006, Chapell 2009, 2010, 2012). In 2009–2011, Chilkat State Park was sampled only during the 5 derby days, when it may have received overflow angler traffic from the more congested Letnikof Cove site (Chapell 2013a, 2013b).

Sampling at Letnikof Dock occurred May 9–June 26 and contained morning/evening stratification and weekend/weekday stratification of evening strata during the peak of the season. Morning sampling strata lasted from 0800 hours until 2 h before midday, and evening sampling strata lasted from 2 h before midday until civil twilight. Thus, evening strata were 4 h longer in duration than morning strata. This stratification scheme was designed to increase the precision of estimates by maximizing sampling during hours when most anglers exit the fishery. Random selections determined primary units to sample in each stratum. Two morning and 2 evening strata were sampled each week, except as noted below. During the peak weeks of the fishery (May 9–June 12), the evening strata at Letnikof Dock were further divided into weekday and weekend strata. During this time, 2 morning, 2 weekday evening, and 2 weekend/holiday evening periods were sampled each week. During the week of June 13–19, 2 morning and 3 evening periods were sampled. The May 23–June 5 biweek, which included the five *Haines King Salmon Derby* days, was divided into a 9-day nonderby stratum and a 5-day derby stratum. Three of 5 morning derby and 3 of 5 evening derby periods were sampled. Three of 9 morning nonderby and 3 of 9 evening nonderby periods were sampled. In total, 17 unique strata were sampled at Letnikof Dock.

Sampling at the low-use Small Boat Harbor site took place May 9–June 26. There was no weekday/weekend stratification. Each biweekly period was divided into 14 morning and 14 evening periods of equal length; 3 morning and 3 evening periods were sampled each biweek, except May 23–June 5. That biweek, which included the 5 *Haines King Salmon Derby* days, was divided into a 9-day nonderby stratum and a 5-day derby stratum. Two of 9 morning nonderby periods and 2 of 9 evening nonderby periods were sampled. The derby stratum was not further stratified by time of day, and 2 of 10 derby periods were sampled. In total, 9 unique strata were sampled at the Small Boat harbor.

The Chilkat State Park boat launch site was sampled during one 5-day stratum of *Haines King Salmon Derby* days, May 28–30 and June 4–5. With no time of day stratification, 2 of 10 periods were sampled.

Random selections determined which primary units to sample within each stratum at all 3 sites. To accommodate the impossibility of sampling 3 sites simultaneously with 2 technicians who could sample one period each per day, 6 changes (period moves) were made to randomly selected sample periods at low-use sites.

During each sample period, all sport fishing boats returning to the harbor were counted. Boat parties returning to the dock were interviewed to determine: the number of rods fished, hours fished targeting salmon using trolling gear, hours fished targeting nonsalmon species or using nontrolling rod-and-reel gear, type of trip (charter or noncharter), target species (Chinook salmon, Pacific halibut *Hippoglossus stenolepis*, or other), and number of fish caught/kept by species. Boat-party interviews also included sampling harvested Chinook salmon for maturity and missing adipose fins. Maturity was determined by either observing external secondary characteristics (Appendix A in Ericksen 1994) or by observing gonads in order to estimate the harvest of wild mature fish, which were assumed to be returning to the Chilkat River. In rare cases some parties were not interviewed or maturity status could not be determined. When one or more boat parties could not be interviewed, total effort and catch for the stratum were estimated by expanding by the total number of parties returning to the dock during that period. Similarly, when a boat party had fish of undetermined maturity status, interview information for that boat party was ignored and expansions (by sample period) were made from harvests by remaining boat parties and the total number of boat parties counted.

The harvest in each stratum ($\hat{H}_h$) was estimated (Thompson 2002):

$$\hat{H}_h = D_h \overline{H}_h \tag{9}$$

$$\overline{H}_h = \frac{\sum_{i=1}^{d_h} \hat{H}_{hi}}{d_h} \tag{10}$$

$$\hat{H}_{hi} = M_{hi} \frac{\sum_{j=1}^{m_{hi}} h_{hij}}{m_{hi}} \tag{11}$$

where h_{hij} is the harvest on boat j in sampling days (periods) i in stratum h, m_{hi} is the number of boat parties interviewed in day i, M_{hi} is the number of boat-parties counted in day i, d_h is the number of days (morning or evening periods) sampled in stratum h, and D_h is the number of days in stratum h. The variance of the harvest by stratum was estimated:

$$\begin{aligned} var\left[\hat{H}_h\right] &= (1-f_{1h})D_h^{\ 2}\frac{\sum_{i=1}^{d_h}(\hat{H}_{hi}-\overline{H}_h)^2}{d_h(d_h\text{-}1)} \\ &+ D_h\sum_{i=1}^{d_h}M_{hi}^{\ 2}(1-f_{2hi})\frac{\sum_{j=1}^{m_{hi}}(h_{hij}\text{-}\overline{h}_{hi})^2}{d_h m_{hi}(m_{hi}\text{-}1)} \end{aligned} \tag{12}$$

where f_{1h} is the sampling fraction for periods and f_{2hi} is the sampling fraction for boat-parties. Catch and effort was estimated similarly, substituting C and E for H in equations (9) through (11). Total harvest for the season was summed across strata ΣH_h and $\Sigma var[H_h]$. Similarly, effort and harvest by charter boat anglers were estimated by considering only data collected from chartered anglers in equations (9) through (11). Angler effort targeting salmon using trolling gear was calculated in salmon-h, and effort targeting all fish species and all rod-and-reel gear, including salmon trolling, was calculated in angler-h.

Chinook salmon were measured to the nearest 5 mm FL and sampled for age by collecting scale samples as described above in event 1 methods. Information recorded for each Chinook salmon sampled included sex, length, maturity, scale sample number, and presence or absence of adipose fins.

For each sampling site, age composition (p_a) was estimated for each stratum by substituting $p_{a,h}$, $n_{a,h}$, and n_h, for p_a, n_a, and n in equations (3) and (4), where h denotes a time, harbor, or time-harbor stratum, and $p_{a,h}$ is the proportion with estimated age a in stratum h, $n_{a,h}$ is the subset of n_h in stratum h having estimated age a, and n_h is the number succesSFully aged in stratum h. Because sampling was not proportional across strata, the estimate for the whole fishery was estimated as:

$$\hat{p}_a = \frac{\sum_h \hat{H}_h\ \hat{p}_{a,h}}{\sum_h \hat{H}_h} \tag{13}$$

where the estimated harvests supply appropriate ‘weights’ for the different stratum sizes. Variance was approximated as:

$$\begin{aligned} \mathrm{var}(\hat{p}_a) &\cong \hat{H}^{-2}\sum_h \hat{H}_h^2\ \mathrm{var}\left(\hat{p}_{a,h}\right) \\ &+ \hat{H}^{-2}\sum_h \mathrm{var}\left(\hat{H}_h\right)\left(\hat{p}_{a,h}-\hat{p}_a\right)^2 \end{aligned} \tag{14}$$

where the approximation is from a second order Taylor's series expansion around the expected values of the parameter estimates and substituting estimated values for the expected values (Mood et al. 1974, p. 181).

Contribution of Coded Wire Tagged Stocks to the 2011 Haines Marine Sport Fishery

Each head collected in the marine sport fishery from a Chinook salmon with a missing adipose fin was marked with a uniquely numbered plastic strap cinched around the jaw. Heads and CWT recovery data were sent to the CF Tag Lab where heads were dissected, CWTs recovered and decoded, and all corresponding information was entered into the CF Tag Lab database.

The contribution of all CWT-tagged stocks to the 2011 Haines marine boat sport fishery was estimated:

$$\hat{r}_{ij} = \hat{H}_i \left(\frac{m_{ij}}{\lambda_i n_i} \right) \hat{\theta}_j^{-1} \tag{15}$$

where $\hat{H}_i$ is the estimated harvest in stratum *i*, $\hat{\theta}_j$ is the fraction of stock *j* marked with CWTs, n_i is the subset of $\hat{H}_i$ examined for missing adipose fins, m_{ij} is the number of decoded CWTs recovered from stock *j*, and λ_i adjusts for imperfect tracking and decoding of CWTs from recovered salmon. See Bernard and Clark (1996) for further details. Statistics were stratified by biweek.

Variance of $\hat{r}_{ij}$ was estimated by means of the appropriate large-sample formulations in Bernard and Clark (1996, their Table 2) for wild or hatchery stocks harvested in the sport fishery. The total contribution of 1 or more cohorts to 1 or more fisheries is the sum of harvests and variances from the individual cohorts and strata.

JUVENILE TAGGING

Juvenile Chinook salmon from BY 2010 were captured using minnow traps in the Chilkat River drainage during fall of 2011 (parr) and in the Chilkat River mainstem during spring of 2012 (smolts). Each juvenile Chinook salmon was marked with an adipose fin clip and a CWT, then was released close to the capture site. Smolts tagged in spring 2012 were given a second CWT implanted in the muscle tissue beneath the posterior insertion of the dorsal fin to distinguish spring-tagged from fall-tagged fish of the same brood year.

In fall 2011, trapping began in upriver locations and moved downstream as the season progressed (Figure 1). The Tahini River was trapped September 25–28, the Kelsall River October 3–11, and the Chilkat River from the mouth of the Kelsall River down to Haines Highway MP 13 October 17–28. In spring 2012, the lower Chilkat River (MP 5–21) was trapped April 10–May 28.

A crew consisting of 4 people fished approximately 100 traps per day. Traps were baited with disinfected salmon roe and checked at least once per day. Crew members immediately released nontarget species at the trapping site. Remaining fish were transported to holding boxes for processing at a central tagging location.

Following the methods in Koerner (1977), all healthy Chinook juveniles ≥50 mm FL were injected with a CWT and externally marked by excision of the adipose fin. Prior to marking, fish were first tranquilized in a solution of tricaine methanesulfonate (MS 222) buffered with sodium bicarbonate. In fall 2011, every 100th fish marked with a CWT was additionally measured to the nearest mm FL. In spring 2012, every 20th fish marked was measured to the nearest mm FL and weighed to the nearest 0.1 g.

All marked fish were held overnight to check for handling-induced mortality, and a subset of which were evaluated for 24-h CWT retention. The following morning, 100 fish in the previous day's catch were randomly selected and checked for the retention of CWTs and mortality. If tag retention was 98% or greater, mortalities were counted and all live fish from that batch were released. If tag retention was less than 98%, the entire batch was checked for tag retention and those that tested negative were retagged. The number of fish tagged, number of tagging-related mortalities, and number of fish that had shed their tags were compiled and submitted to the CF Tag Lab at the completion of the field season.

BROOD YEAR 2004 PRODUCTION

Juvenile Abundance

Ericksen and Chapell (2006) reported the methods used to mark BY 2004 Chinook salmon parr in fall 2005 and smolts in spring 2006 with CWTs and adipose fin clips in the Chilkat River drainage. Between 2007 and 2011, the CF sampled landings from commercial drift gillnet, set gillnet, purse seine, and troll fisheries throughout Southeast Alaska and Yakutat for adipose fin clips and CWTs. During summer and early fall, samplers were stationed at processors in Ketchikan, Craig, Wrangell, Petersburg, Sitka, Pelican, Port Alexander, Elfin Cove, Excursion Inlet, Juneau, and Yakutat. The sample goal was to inspect at least 20% of the total catch of Chinook salmon for missing adipose fins. Heads from fish missing their adipose fin were sent to the CF Tag Lab on a weekly basis where CWTs were removed and decoded. The annual CF port sampling manual (ADF&G *unpublished*, available from the CF Tag Lab, Juneau) provides a detailed explanation of commercial catch sampling procedures and logistics. The number of BY 2004 Chilkat River Chinook salmon CWTs recovered during 2007–2011 in all marine fisheries (commercial, sport, and subsistence) was tallied by release period, whether fall 2005 or spring 2006, as determined by the tag code read at the CF Tag Lab.

In Chilkat River escapement sampling during 2007–2011, heads were taken from all Chinook salmon with clipped adipose fins, except large (≥660 mm FL) fish in prespawning condition. The brood year of adipose-finclipped fish whose heads were not taken was determined from scale samples. As described in event 1 methods, all adipose-finclipped fish were examined with a handheld wand CWT detector to determine presence/absence of 2 CWTs: the first in the head, and the second in the musculature at the base of the dorsal fin. To avoid false positive wand scan results, field staff was trained to avoid magnetized items in the sampling area, such as high-iron gravel, screws in the sampling trough, tools in pockets, zippers, etc. To avoid false negative wand scan results, field staff was trained to insert the wand inside the mouths of large fish (Vander Haegen et al. 2002).

For fish whose heads were taken that contained CWTs recovered by the CF Tag Lab, the wand determination of second CWT presence/absence was compared with the season tagged from the decoded CWT. A correct determination of season tagged by the wand method was defined as either detecting the presence of the second CWT in spring-tagged fish, or the absence of the second CWT in fall-tagged fish.

To assess the accuracy of the wand scan method, wand scan results from sampling calendar years 2007–2011 were tallied by correct, false positive, and false negative second CWT identifications (Appendix D2). The rate of false positive (ω_{f+}) and false negative (ω_{f-}) identifications was used to adjust the error associated with estimates of spring-tagged and fall-tagged fish in the BY 2004 return. To assess sampling bias by body size, the second CWT false detection rates for large (≥660 mm MEF) and medium/small (<660 mm MEF) were compared using χ^2 tests on fish tagged in the fall vs. fish tagged in the spring. If a cell value in the contingency table was <5, then a Yates (1934) correction was used.

A statistical model was fit to the Chilkat River Chinook salmon BY 2004 data to estimate the number of BY 2004 parr rearing in fall 2005 (N_{PARR}), the overwinter survival to spring 2006 (ϕ_I), the number of smolts outmigrating in 2006 (N_{SMOLT}), and the false negative (ω_{f-}) and the false positive (ω_{f+}) error rates. The number of fish assigned to fall and spring marking events among all BY 2004 Chinook salmon sampled in the Chilkat River from 2007 to 2011 was modeled as having a multinomial distribution with parameters π_1, π_2, π_3, π_4, and C where:

$\pi_1 = ((1 + \omega_{f+})*q_{FALL} - \omega_{f-}*q_{SPRING})*\rho$,

$\pi_2 = ((1 + \omega_{f-})*q_{SPRING} - \omega_{f+}*q_{FALL})*\rho$,

$\pi_3 = (q_{FALL} + q_{SPRING})\ (1 - \rho)$,

$\pi_4 = 1 - \pi_1 - \pi_2 - \pi_3$,

$q_{FALL} = M_{PARR} / N_{PARR}$,

$q_{SPRING} = M_{SMOLT} / N_{SMOLT}$, and

$C = R_1 + R_2 + R_3 + R_4$ = the total number of adult BY 2003 Chinook salmon examined for adipose fin clips in the Chilkat River in 2006–2010, where:

R_1 = the number of adipose-finclipped adult fish with wand scan result second CWT absent, implying a fall-tagged fish

R_2 = the number of adipose-finclipped adult fish with wand scan result second CWT present, implying a spring-tagged fish

R_3 = the number of adipose-finclipped adult fish with no wand scan result

R_4 = the number of adult fish without adipose fin clips,

ρ = the proportion of adipose-clipped adult fish that were wand scanned and assigned a fall or spring tagging event,

M_{PARR} = number of CWT-tagged parr released during fall 2005,

M_{SMOLT} = number of CWT-tagged smolts released during spring 2006, and

falseposDorsal = the number of adult fish known to have been CWT-tagged in the fall that had a positive second CWT scan result in 2005–2012,

correct.ID.NoDorsal = the number of adult fish known to have been CWT-tagged in the fall that had a negative second CWT scan result in 2005–2012, *falsenegDorsal* = the number of adult fish known to have been CWT-tagged in the spring that had a negative second CWT scan result in 2005–2012,

correct.ID.Dorsal = the number of adult fish known to have been CWT-tagged in the spring that had a positive second CWT scan result in 2005–2012.

The relative proportion of fall and spring CWTs recovered elsewhere (fisheries outside of the Chilkat River) also contained information about the survival probability ϕ_I. Therefore the number of valid CWTs from the fall 2005 marking event recovered from Chinook salmon sampled elsewhere from 2007 to 2011 was modeled as having a binomial distribution with parameters:

$\pi_{FALL} = q_{FALL} / (q_{FALL} + q_{SPRING})$,

and m = number of BY 2004 Chilkat River Chinook salmon fall and spring CWTs recovered in fisheries outside of the Chilkat River from 2007 to 2011.

Bayesian statistical methods were used to estimate abundance parameters for juvenile Chinook salmon abundance. A normal prior distribution with very large variance was specified for N_{PARR}, essentially equivalent to a uniform distribution. A beta (0.3, 0.3) prior was used for ϕ_I and a beta (0.1, 0.1) prior was used for ρ. These priors were noninformative, chosen to have a negligible effect on the posterior. Informative priors for ω_{f-} and ω_{f+} were based on the known wand results from 2005 through 2012, the most recent year of available data. For ω_{f-}, a beta (7, 63) prior was used where the 7 is equal to the number of false negative wand results for the dorsal CWT, and the 63 is the number of correctly identified dorsal CWTs. For ω_{f+}, a beta (11, 182) prior was used where the 11 is equal to the number of false positive wand results for the dorsal CWT, and 82 is the number of correctly identified fish without a dorsal CWT.

Markov-Chain Monte Carlo simulation, implemented with the Bayesian software WinBUGS (Gilks et al. 1994), was used to draw samples from the joint posterior probability distribution of all unknowns in the model (Appendix E1). Three Markov chains were initiated, a 4,000-sample burn-in period discarded, and 400,000 updates generated to estimate the marginal posterior means, standard deviations, and percentiles. The diagnostic tools of WinBUGS were used to assess mixing and convergence. Interval estimates were obtained from percentiles of the posterior distribution.

Adult Harvest

Harvest of BY 2004 Chilkat River Chinook salmon was estimated from fish sampled for CWTs in marine commercial, sport, and subsistence fishery harvests, and in the Chilkat River escapement to determine the fraction θ_h of BY 2004 fish carrying a CWT.

Because several fisheries exploited Chinook salmon over several months and years, harvest was estimated over several strata, each a combination of time, area, and type of fishery. Statistics from the commercial troll fishery were stratified by troll fishing period and quadrant. Statistics from drift gillnet fisheries were stratified by statistical week and district. Statistics from the Haines area marine subsistence gillnet fishery were stratified by year. In sport fisheries where creel survey programs estimate harvest, statistics were stratified by fortnight (biweek). In sport fisheries with no biweekly harvest estimates from creel surveys, annual Statewide Harvest Survey (e. g., Jennings et al. 2012) data were used and statistics were stratified by year. Hubartt et al. (1997) and Bingham et al (2013) describe methods of sampling sport fisheries in Southeast Alaska.

Estimates of harvest were summed across strata and across fisheries to obtain an estimate of the total harvest, $\hat{T}$:

$$\hat{T} = \sum_i \hat{r}_i \tag{16}$$

$$\mathrm{v}[\hat{T}] = \sum_i \mathrm{v}[\hat{r}_i] \tag{17}$$

$$SE[\hat{T}] = \sqrt{var[\hat{T}]} \tag{18}$$

Variance was estimated as the sum of variances across strata (no covariance terms required) because sampling was independent across strata and fisheries.

Return (harvest plus escapement) of BY 2004 Chilkat River Chinook salmon was estimated as:

$$\hat{R} = \hat{T} + \hat{S} \tag{19}$$

$$var[\hat{R}] = var[\hat{T}] + var[\hat{S}] \tag{20}$$

$$SE[\hat{R}] = \sqrt{var[\hat{R}]} \tag{21}$$

where $\hat{S}$ is the total escapement of age-1.2 and older BY 2004 fish estimated between 2008 and 2011.

The fraction of the return harvested (the exploitation rate) was calculated as:

$$\hat{\mu} = \frac{\hat{T}}{\hat{R}} = \frac{\hat{T}}{\hat{S} + \hat{T}} \tag{22}$$

$$var[\hat{\mu}] \approx \frac{var[\hat{T}]\hat{S}^2}{\hat{R}^4} + \frac{var[\hat{S}]\hat{T}^2}{\hat{R}^4} \tag{23}$$

$$SE[\hat{\mu}] = \sqrt{var[\hat{\mu}]} \tag{24}$$

where the approximate variance was derived by the delta method (Seber 1982).

The estimated marine survival rate (smolt-to-age-1.2 and older) and the delta method approximation of its variance were calculated as:

$$\hat{\phi}_2 = \frac{\hat{R}}{\hat{N}_{SMOLT}} \tag{25}$$

$$var[\hat{\phi}_2] \approx \hat{\phi}_2^2 \left[\frac{var[\hat{R}]}{\hat{R}^2} + \frac{var[\hat{N}_{SMOLT}]}{\hat{N}_{SMOLT}^2} \right] \tag{26}$$

$$SE[\hat{\phi}_2] = \sqrt{var[\hat{\phi}_2]} \tag{27}$$

RESULTS

INRIVER RUN ESTIMATE

In event one, 222 large (age 1.3 and older), 104 medium (age 1.2), and 34 small (age 1.1) Chinook salmon were captured in the lower Chilkat River with drift gillnets and fish wheels between June 9 and August 24, 2011 (Table 2). Of those captured, 216 large, 95 medium, and 32 small fish were given a uniquely numbered external tag. Seventeen (17) fish were not marked for several reasons: 2 large, 9 medium, and 2 small fish were sacrificed for CWT recovery; 3 large fish escaped the sampling trough before being marked; and 1 large fish captured on August 24 would have had insufficient time to reach the event 2 sampling areas (Figure 1).

The daily number of large Chinook salmon captured peaked on July 7 (Figure 3). The mean of the immigration timing density was July 6 for large fish and July 7 for all sizes combined (Figures 3 and 4; Mundy 1984).

In event 2 of the mark-recapture study, 569 large, 199 medium, and 1 small Chinook salmon were captured on the spawning grounds, of which 43 large, 17 medium, and 0 small fish were marked (Table 3). There was 1 case of primary tag loss in a carcass that had been partially eaten.

Table 2.–Number of Chinook salmon captured, marked, and released in event 1, lower Chilkat River, by time period, gear type, and age category, June 9–August 27, 2011.

	Drift gillnet			Fish wheels			Combined			
Time period	Large	Med	Small	Large	Med	Small	Large	Med	Small	Total
June 9–13	4	0	0	1	1	4	5	1	4	10
June 14–18	5	0	0	10[a]	6[b]	4	15	6	4	25
June 19–23	7	2	0	7	5[c]	1	14	7	1	22
June 24–28	2	1	0	21[d]	18[e]	5	23	19	5	47
June 29–July 3	19	1	0	14	7[f]	9[g]	33	8	9	50
July 4–8	33	7	0	19[h]	11	5	52	18	5	75
July 9–13	18	4	0	9	14[i]	3	27	18	3	48
July 14–18	13	2	0	16[j]	13[k]	2	29	15	2	46
July 19–23	4	3	0	7	7[l]	1	11	10	1	22
July 24–28	2	0	0	5	2	0	7	2	0	9
July 29–August 2	–[m]	–[m]	–[m]	2	0	0	2	0	0	2
August 3–7	–[m]	–[m]	–[m]	1	0	0	1	0	0	1
August 8–12	–[m]	–[m]	–[m]	1	0	0	1	0	0	1
August 13–17	–[m]	–[m]	–[m]	1	0	0	1	0	0	1
August 18–22	–[m]	–[m]	–[m]	0	0	0	0	0	0	0
August 23–27	–[m]	–[m]	–[m]	1[n]	0	0	1	0	0	1
Total captured	107	20	0	115	84	34	222	104	34	360
Total marked	107	20	0	109	75	32	216	95	32	343

Note: Large = age 1.3 and older, Med = age 1.2, and Small = age 1.1.

[a] 1 Large not marked.
[b] 1 Med not marked.
[c] 1 Med not marked.
[d] 2 Large not marked.
[e] 2 Med not marked.
[f] 1 Med not marked.
[g] 2 Small not marked.
[h] 1 Large not marked.
[i] 2 Med not marked.
[j] 1 Large not marked.
[k] 1 Med not marked.
[l] 1 Med not marked.
[m] Drift gillnet effort ended July 24, 2011.
[n] 1 Large not marked.

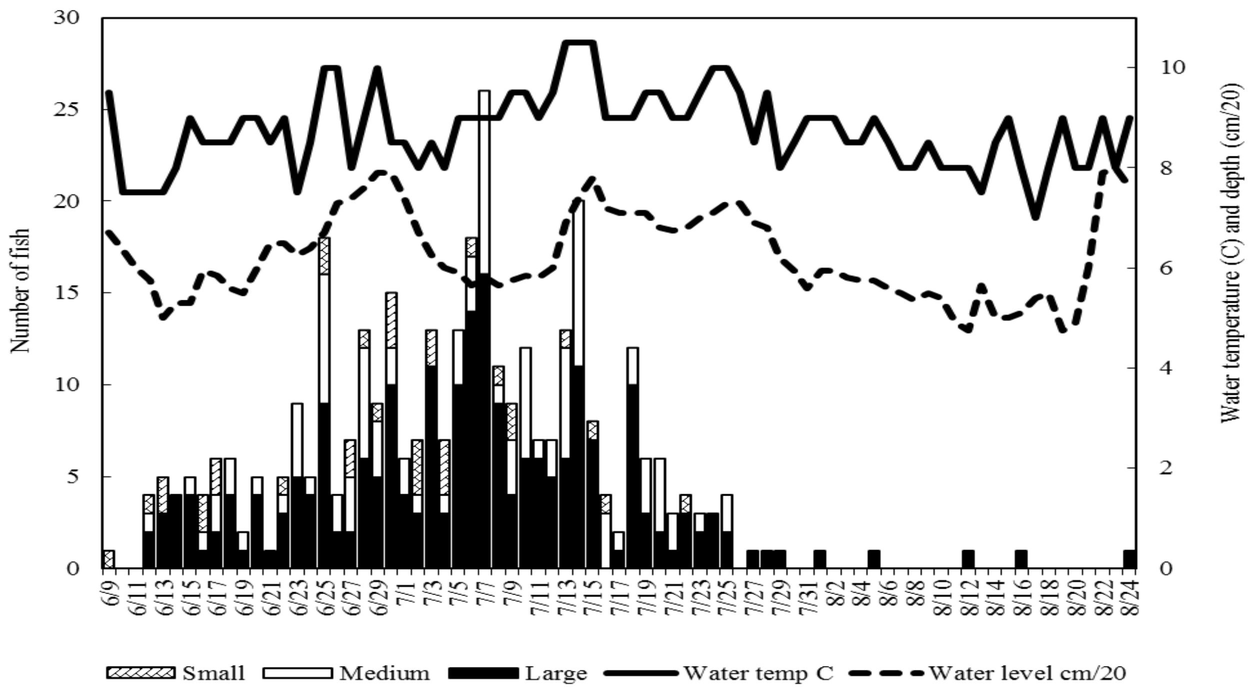

Figure 3.–Daily water depth, temperature, and catches of small, medium, and large Chinook salmon in event 1 drift gillnets and fish wheels, June 9–August 24, 2011.

Note: Small = age 1.1; medium = age 1.2; large = age 1.3 and older.

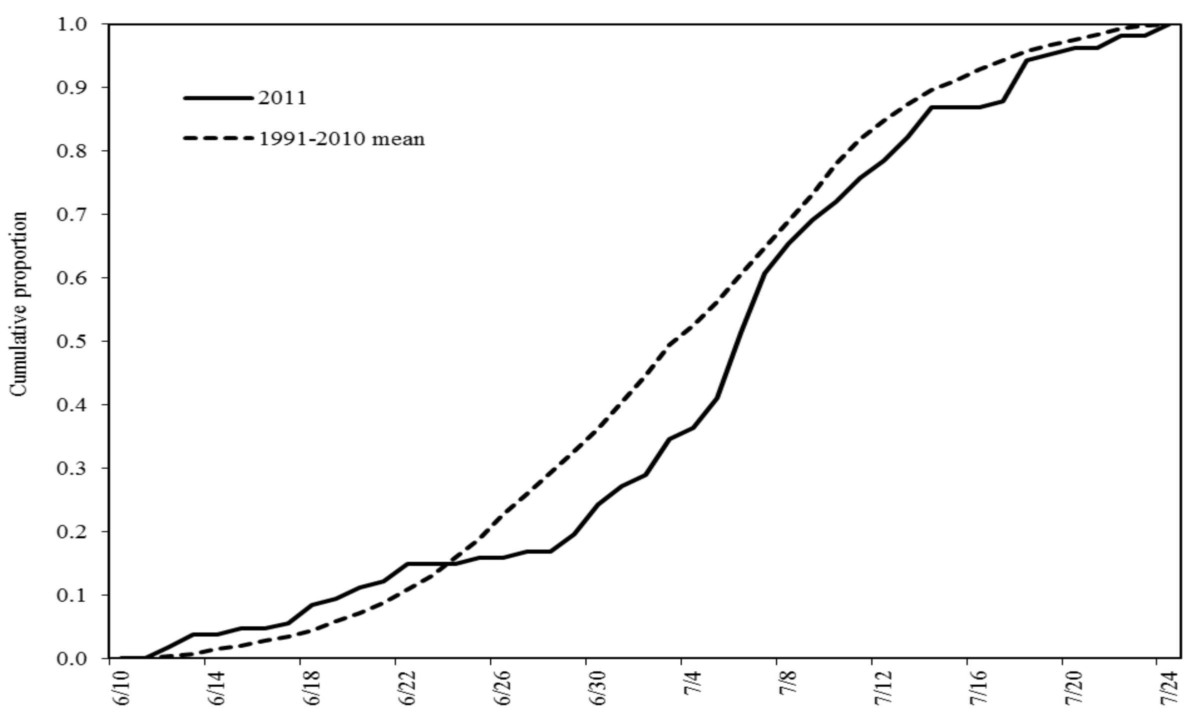

Figure 4.–Cumulative proportion of large (≥age 1.3) Chinook salmon captured in event 1 with drift gillnets in the lower Chilkat River June 9–July 24, 2011 compared to the mean cumulative proportion, 1991–2010.

Table 3.–Number of Chinook salmon inspected for marks and number of recaptured fish in event 2, by Chilkat River tributary, age category, and sex, in 2011.

		Captured									Recaptured								
		Large				Medium			Small		Large				Medium			Small	
Tributary	Dates	F	M	U	Total	F	M	Total	M	Total	F	M	U	Total	F	M	Total	M	Total
Kelsall River	8/02–9/02	96	102	0	198	3	30	33	0	0	14	6	0	20	1	3	4	0	0
Tahini River	8/02–8/31	197	121	1	319	0	126	126	1	1	14	5	0	19	0	11	11	0	0
37-Mile Cr	8/11–8/31	6	5	0	11	0	1	1	0	0	0	0	0	0	0	0	0	0	0
Big Boulder	8/04–8/27	18	22	0	40	0	39	39	0	0	1	2	0	3	0	2	2	0	0
Little Boulder	8/11–8/31	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total		318	250	1	569	3	196	199	1	1	30	13	0	43	1	16	17	0	0

Note: Large = age 1.3 and older, Medium = age 1.2, and Small = age 1.1, M = male, F = female, U = unknown.

Recapture rates of marked fish were not significantly different ($\chi^2 = 0.04$, df = 1, P = 0.85) for fish marked in the first half of event 1 (29 fish recaptured of 164 fish marked June 9–July 5) versus the second half (30 fish recaptured of 179 fish marked July 6–August 16), so the Petersen-type model used to estimate the inriver run was not stratified by time. The marked fractions of all sizes of Chinook salmon sampled at the three tributaries (Kelsall River 10.4%, Tahini River 6.7%, Klehini tributaries 6.5%) were not different ($\chi^2 = 2.56$, df = 2, P = 0.28), so the abundance estimate was not stratified by area.

The length distribution of Chinook salmon marked in the lower Chilkat River (combined fish wheel and drift gillnet captures) was not different enough (*M* vs. *R*, K-S test, D = 0.148, P = 0.159) from that of marked Chinook salmon recaptured on the spawning grounds to reject the null hypothesis (Figure 5, top panel). The length distribution of all fish captured in event 2 was not significantly different (*C* vs. *R*, K-S test, D = 0.068, P = 0.949) from that of the marked fish recaptured in event 2 (Figure 5 middle panel). The length distribution of all fish marked in event 1 was significantly different (*M* vs. *C*, K-S test, D = 0.142, P < 0.001) from that of the captured fish recaptured in event 2 (Figure 5 bottom panel). Following the protocol outlined in Appendix A1, these results indicated further analysis was required. Because the *M* vs. *R* p-value was not large (<0.20), and because of potentially poor power associated with this test, the conservative approach was taken and it was assumed that there was no size selectivity during the first event but there was during the second event (Case II). As a result, the abundance estimate was not stratified by size, and event 1 data was used to estimate the size/age composition of the run.

The sex composition of Chinook salmon marked in event 1 was different (*M* vs. *R*, $\chi^2 = 4.59$, df = 1, P = 0.03) from that of marked Chinook salmon recaptured on the spawning grounds, but the sex composition of all fish captured in event 2 was not significantly different (*C* vs. *R*, $\chi^2 = 2.22$, df = 1, P = 0.14) from that of the marked fish recaptured in event 2 (Table 4). The sex composition of all fish marked in event 1 was not significantly different (*M* vs. *C*, $\chi^2 = 2.22$, df = 1, P = 0.13) from that of the marked fish captured in event 2. These results indicated further analysis was required. Because the *M* vs. *C* p-value was not large (<0.20), and the *R* sample size was relatively small (31 fish), the conservative approach taken was to assume there was no sex selectivity during the first event but there was during the second event (Case II), so the abundance estimate was not stratified by size, and event 1 data was used to estimate the sex composition of the run.

Sex identification during event 1 has historically been unreliable for this project (Table 5). Based on 59 recaptured fish, the 2011 sex identification error rate (12%) was average.

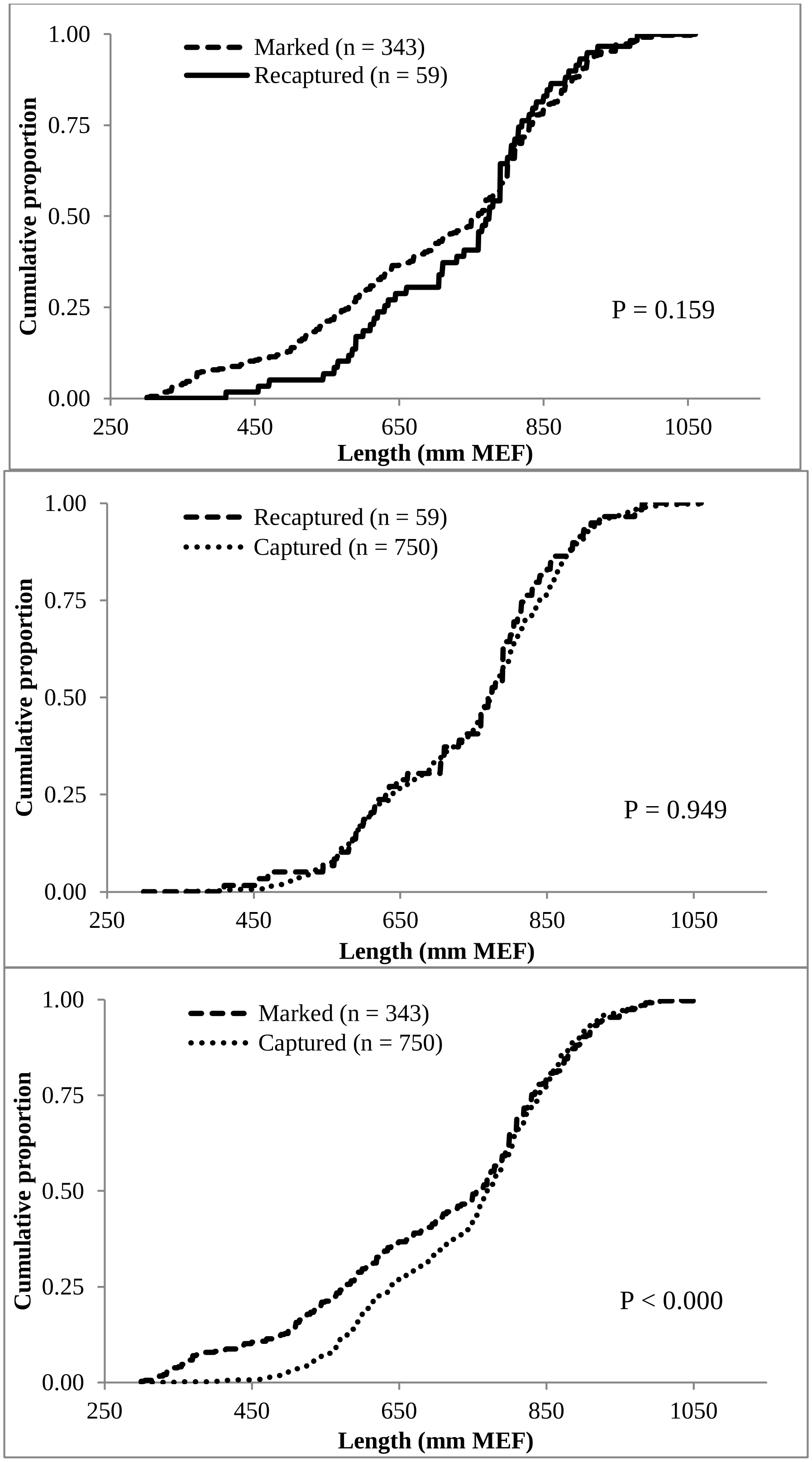

Figure 5.–Comparisons of length (mm MEF) distributions and Kolmogorov-Smirnoff test results (P-value) of Chilkat River Chinook salmon in the 2011 mark-recapture experiment; marked vs. recaptured (top), captured vs. recaptured (middle), and marked vs. captured (bottom).

Table 4.–Contingency table tests for evaluation of sex selectivity in Chilkat River Chinook salmon mark-recapture events 1 and 2, in 2011.

	Number of fish		Percent
	Male	Female	Female
Marked	216	127	37
Captured	447	321	42
Recaptured	29	31	52
Comparison	χ^2	df	P
Marked vs. recaptured	4.59	1	0.03
Captured vs. recaptured	2.22	1	0.14
Marked vs. captured	2.24	1	0.13

Table 5.–Sex determination error rates in recaptured fish, Chilkat River Chinook salmon mark–recapture studies, 1991–2011.

Year	Number of recaptures examined	Number incorrectly sexed	Error rate	Data source
1991	24	3	0.13	Ericksen (1995)
1992	24	4	0.17	Ericksen (1995)
1993	21	2	0.10	Ericksen (1995)
1994	32	3	0.09	Ericksen (1995)
1995	17	4	0.24	Ericksen (1996)
1996	31	5	0.16	Ericksen (1997)
1997	29	5	0.17	Ericksen (1998)
1998	28	2	0.07	Ericksen (1999)
1999	32	7	0.22	Ericksen (2000)
2000	37	5	0.14	Ericksen (2001)
2001	46	11	0.24	Ericksen (2002a)
2002	54	4	0.07	Ericksen (2003)
2003	59	9	0.15	Ericksen (2004)
2004	43	1	0.02	Ericksen (2005)
2005	28	5	0.18	Ericksen and Chapell (2006)
2006	32	1	0.03	Chapell (2009)
2007	25	3	0.12	Chapell (2010)
2008	22	0	0.00	Chapell (2012)
2009	29	3	0.10	Chapell (2013a)
2010	29	1	0.03	Chapell (2013b)
2011	59	7	0.12	
1991–2010 average	33	4	0.12	

An estimated 4,341 (SE = 480) Chinook salmon of all ages immigrated into the Chilkat River in 2011 (Table 6). This estimate is germane to the time of marking at the event 1 site (Figure 1).

Table 6.–Unstratified inriver run estimate and sampling statistics of Chilkat River Chinook salmon, 2011.

Marked	Examined	Recaptures	Abundance	
n_1	n_2	m_2	$\hat{N}_a$	SE [$\hat{N}_a$]
343	769	60	4,341	480

Age, Sex, and Length Composition of the Inriver Run

Chinook salmon captured in event 1 gillnets were predominantly age 1.3 (55.4%) or age 1.4 (28.9%) and classified as female (52.0%; Table 7). More than half (79 out of 127) of drift gillnet-caught fish were caught in the large mesh (8 in) panel. Fish captured in the event 1 fish wheels were classified mostly as males (72.1%) and were most frequently age 1.2 (36.8%) and age 1.3. The event 1 combined gear age composition was 8.7% age 1.1, 29.4% age 1.2, 42.2% age 1.3, 19.5% age 1.4 (SE = 1.5%, 2.5%, 2.7%, and 2.1%, respectively). Following the Case II protocol in Appendix A1, the event 1 age and sex proportions were used to estimate the inriver abundance-at-age at 379 (SE = 78) age-1.1, 1,275 (SE = 176) age-1.2, 1,830 (SE = 233) age-1.3, 846 (SE = 131) age-1.4, and 13 age-1.5 (SE = 13) fish (Table 8). The large component of the inriver run totaled 2,688 (SE = 368) large Chinook salmon (age-1.3 and older).

Of the 768 Chinook salmon sampled for age and sex in spawning tributaries, 723 were succesSFully aged (Table 9). The most frequent age-sex category in the Kelsall River was age-1.3-female. The composition of large vs. medium/small fish was different (χ^2 = 30.0, df = 2, P < 0.001) among the three tributaries. The Kelsall River had the highest percentage (85%) of large (age 1.3 and older) Chinook salmon (from samples succesSFully aged), followed by the Tahini River (70%) and the Klehini River (56%).

Table 7.–Age composition and mean length-at-age (mm MEF) of Chinook salmon sampled during event 1, in the Chilkat River, by gear type, 2011.

		Brood year and age class						
		2008	2007	2006	2005	2004	Total	Total
		1.1	1.2	1.3	1.4	1.5	aged	sampled[a]
FISH WHEELS								
Males	Sample size	30	79	41	12	0	162	168
	Percent	18.5	48.8	25.3	7.4	0.0	–	72.1
	SE(%)	3.1	3.9	3.4	2.1	–	–	2.9
	Mean length	352	551	743	885	–	–	–
	SD	28	53	71	85	–	–	–
Females	Sample size	0	3	37	20	1	61	65
	Percent	0.0	4.9	60.7	32.8	1.6	–	27.9
	SE(%)	–	2.8	6.3	6.0	1.6	–	2.9
	Mean length	–	590	784	861	950	–	–
	SD	–	28	48	70		–	–
All fish	Sample size	30	82	78	32	1	223	233
	Percent	13.5	36.8	35.0	14.3	0.4	–	–
	SE(%)	2.3	3.2	3.2	2.3	0.4	–	–
	Mean length	352	553	763	870	950	–	–
	SD	28	53	64	76		–	–

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		Brood year and age class						
		2008	2007	2006	2005	2004	Total	Total
		1.1	1.2	1.3	1.4	1.5	aged	sampled[a]
		DRIFT GILLNET						
Males	Sample size	0	18	30	12	0	60	61
	Percent	0.0	30.0	50.0	20.0	0.0	–	48.0
	SE(%)	–	5.9	6.5	5.2	–	–	4.5
	Mean length	–	621	797	935	–	–	–
	SD	–	51	82	53	–	–	–
Females	Sample size	0	1	37	23	0	61	66
	Percent	0.0	1.6	60.7	37.7	0.0	–	52.0
	SE(%)	–	1.6	6.3	6.2	–	–	4.5
	Mean length	–	610	815	880	–	–	–
	SD	–	–	60	40	–	–	–
All fish	Sample size	0	19	67	35	0	121	127
	Percent	0.0	15.7	55.4	28.9	0.0	–	–
	SE(%)	–	3.3	4.5	4.1%	–	–	–
	Mean length	–	621	807	899	–	–	–
	SD	–	49	71	51	–	–	–
		COMBINED LOWER RIVER GEAR						
Males	Sample size	30	97	71	24	0	222	229
	Percent	13.5	43.7	32.0	10.8	0.0	–	64.5
	SE(%)	2.3	3.3	3.1	2.1	0.0	–	2.6
	Mean length	352	564	766	910	–	–	–
	SD	28	59	80	74	–	–	–
Females	Sample size	0	4	74	43	1	122	131
	Percent	0.0	3.3	60.7	35.2	0.8	–	35.5
	SE(%)	–	1.6	4.4	4.3	0.8	–	2.6
	Mean length	–	595	800	871	950	–	–
	SD	–	25	56	56	–	–	–
All fish	Sample size	30	101	145	67	1	344	360
	Percent	8.7	29.4	42.2	19.5	0.3	–	–
	SE(%)	1.5	2.5	2.7	2.1	0.3	–	–
	Mean length	352	566	783	885	950	–	–
	SD	28	59	71	65	–	–	–

[a] Includes fish that were not assigned an age.

Table 8.–Estimated inriver run of Chinook salmon in the Chilkat River, by age and sex, 2011.

	Brood year and age class					
	2008	2007	2006	2005	2004	
	1.1	1.2	1.3	1.4	1.5	Total
Male	379	1,224	896	303	0	2,802
SE	78	171	137	68	-	329
Female	0	50	934	543	13	1,540
SE	-	26	141	98	13	203
All fish	379	1,275	1,830	846	13	4,341
SE	78	176	233	131	13	480

Table 9.–Age composition and mean length-at-age (mm MEF) of Chinook salmon sampled during event 2 in the Chilkat River drainage, by spawning tributary, 2011.

		Brood year and age class						
		2008	2007	2006	2005	2004	Total	Total
		1.1	1.2	1.3	1.4	1.5	aged	sampled[a]
KELSALL RIVER								
Females	Sample size	0	3	66	18	2	89	99
	Percent	0.0	3.4	74.2	20.2	1.6	–	42.9
	SE(%)	–	1.9	4.7	4.3	1.6	–	3.3
	Mean length	–	535	768	853	928	–	–
	SD	–	142	37	41	25	–	–
Males	Sample size	0	30	82	15	1	128	132
	Percent	0.0	23.4	64.1	11.7	0.8	–	57.1
	SE(%)	–	3.8	4.3	2.9	0.8	–	3.3
	Mean length	–	579	787	83	950	–	–
	SD	–	57	61	92	–	–	–
All fish	Sample size	0	33	148	33	3	217	231
	Percent	0.0	15.2	68.2	15.2	1.4	–	–
	SE(%)	–	2.4	3.2	2.4	0.8	–	–
	Mean length	–	575	779	862	935	–	–
	SD	–	66	53	68	22	–	–
TAHINI RIVER								
Females	Sample size	0	0	59	116	1	176	1997
	Percent	0.0	0.0	33.5	65.9	0.6	–	44.3
	SE(%)	–	–	3.6	3.6	0.6	–	2.4
	Mean length	–	–	782	866	925	–	–
	SD	–	–	37	48		–	–
Males	Sample size	0	125	72	41	1	239	248
	Percent	0.0	52.3	30.1	17.2	0.4	–	55.7
	SE(%)	–	3.2	3.0	2.4	0.4	–	2.4
	Mean length	–	591	743	892	805	–	–
	SD	–	51	79	88	–	–	–
All fish	Sample size	0	125	131	157	2	415	445
	Percent	0.0	30.1	31.6	37.8	0.5	–	–
	SE(%)	–	2.3	2.3	2.4	0.3	–	–
	Mean length	–	591	761	873	865	–	–
	SD	–	51	66	62	85	–	–
KLEHINI RIVER								
Females	Sample size	0	0	18	6	0	24	25
	Percent	0.0	0.0	75.0	25.0	0.0	–	27.2
	SE(%)	–	–	9.0	9.0	–	–	4.7
	Mean length	–	–	746	861	–	–	–
	SD	–	–	35	60	–	–	–
Males	Sample size	0	40	24	3	0	67	67
	Percent	0.0	59.7	35.8	4.5	0.0	–	72.8
	SE(%)	–	6.0	5.9	2.5	–	–	4.7
	Mean length	–	549	721	863	–	–	–
	SD	–	59	83	43	–	–	–
All fish	Sample size	0	40	42	9	0	91	92
	Percent	0.0	44.0	46.2	9.9	0.0	–	–
	SE(%)	–	5.2	5.3	3.1	–	–	–
	Mean length	–	549	732	862	–	–	–

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		Brood year and age class						
		2008	2007	2006	2005	2004	Total	Total
		1.1	1.2	1.3	1.4	1.5	aged	sampled[a]
		COMBINED TRIBUTARIES						
Females	Sample size	0	3	143	140	3	289	321
	Percent	0.0	1.0	49.5	48.4	1.0	–	41.8
	SE(%)	–	0.6	2.9	2.9	0.6	–	1.8
	Mean length	–	535	771	864	927	–	–
	SD	–	142	38	48	18	–	–
Males	Sample size	0	195	178	59	2	434	447
	Percent	0.0	44.9	41.0	13.6	0.5	–	58.2
	SE(%)	–	2.4	2.4	1.6	0.3	–	1.8
	Mean length	–	581	760	885	878	–	–
	SD	–	56	76	87	103	–	–
All fish	Sample size	0	198	321	199	5	723	768
	Percent	0.0	27.4	44.4	27.5	0.7	–	–
	SE(%)	–	1.7	1.8	1.7	0.3	–	–
	Mean length	–	580	765	871	907	–	–
	SD	–	57	62	62	59	–	–
		Sex composition by age class, combined tributaries						
Females	Percent	0	1.5	44.5	70.4	60.0	40.0	41.8
	SE(%)	0.0	0.9	2.8	3.2	24.5	1.8	1.8
Males	Percent	0	98.5	55.5	29.6	40.0	60.0	58.2
	SE(%)	0.0	0.9	2.8	3.2	24.5	1.8	1.8

[a] Total sampled includes 26 large (≥660 mm MEF) fish that were not assigned a valid age, but excludes 5 large carcasses with undetermined sex.

TERMINAL HARVEST

2011 Haines Marine Sport Fishery Harvest

The 2011 Haines marine boat creel survey estimates are based on interviews with 386 boat-parties who fished 5,961 angler-h (5,902 salmon-h, Table 10). The survey estimated that anglers spent a total of 8,734 (SE = 478) angler-h of effort, of which 8,592 (SE = 471) angler-h targeted salmon during May 19–June 26. The estimated total harvest was 217 (SE = 16) large Chinook salmon, of which 174 (SE = 13) were wild mature fish assumed to be returning to the Chilkat River. Anglers caught and released an estimated 557 (SE = 95) small (<28 in TL) Chinook salmon, but creel surveyors encountered no harvested sublegal length fish. Charter anglers accounted for 3% of the salmon effort (289 salmon-h, SE = 117) and 3% of the large Chinook salmon harvest (28 fish, SE = 4). Most (86%) of the estimated Haines marine boat salmon effort was based at Letnikof dock in Chilkat Inlet (Figure 1, Appendices B1–B3).

Creel surveyors sampled 120 Chinook salmon for age, sex, and length in the sport harvest at Letnikof Cove dock and 2 fish at the Haines Small Boat Harbor (Table 11). At Letnikof Cove, the age composition of the sampled harvest was 0.6% (SE = 0.6%) age 0.3, 15.6% (SE = 4.2%) age 1.2, 54.6% (SE = 5.6%) age 1.3, and 29.2% (SE = 4.9%) age 1.4. At the Haines Small Boat Harbor, both sampled fish were age-1.3 males.

Table 10.–Biweekly sampling statistics and estimated effort, catch, and harvest of large (≥28 in TL) and small (<28 in TL) Chinook salmon in the Haines marine sport fishery, May 9–June 26, 2011.

	May 09– May 22	May 23–June 5 Non-Derby	May 23–June 5 Derby	June 06– June 19	June 20– June 26	Total
Boats counted	59	32	125	135	35	386
Angler-hr. sampled	454	316	3,638	1,233	320	5,961
Salmon-hr. sampled	429	316	3,633	1,222	302	5,902
Chinook sampled	0	11	79	26	5	121
Sampled for adipose clips	0	11	79	26	5	121
Adipose clips	0	1	7	3	0	11
Angler-hours						
Estimate	767	945	4,012	2,305	709	8,734
SE	132	187	263	229	233	478
Salmon-hours						
Estimate	714	945	4,003	2,266	667	8,592
SE	128	187	260	221	233	471
Large Chinook catch						
Estimate	0	37	91	73	16	217
SE	0	12	8	7	2	16
Large Chinook harvest						
Estimate	0	37	91	73	16	217
SE	0	12	8	7	2	16
Wild mature large Chinook harvest (excluding hatchery and immature fish)						
Estimate	0	27	64	69	14	174
SE	0	9	4	70	0	13
Small Chinook catch						
Estimate	2	0	138	295	123	557
SE	0	0	61	47	57	95
Small Chinook harvest						
Estimate	0	0	0	0	0	0
SE	0	0	0	0	0	0

Note: Harvest of small Chinook salmon was not allowed in the Haines area in 2011.

Table 11.–Contribution estimate (r) of coded wire tagged Chinook salmon to the Haines marine sport fishery, May 9–June 26, 2011, and statistics used for computing estimates.

			Brood	Harvest		Sample	Adipose clip	Head	Detect	Decode	Tags	Contribution	
Agency	Release site	Tag code	year	*N*	SE[*N*]	*n*	*a*	*a′*	*t*	*t′*	*m*	*r*	SE
CHILKAT INLET RECOVERIES													
ADFG	Chilkat R. wild	04-13-98	2005	212	15	119	11	11	10	10	2	43	30
ADFG	Chilkat R. wild	04-15-57	2006								6	183	75
ADFG	Chilkat R. wild	04-16-87	2007								1	22	22
NSRAA[a]	Lutak Inl. 115-33	04-14-54	2007								1	10	9
Chilkat Inlet total											10	259	84
SMALL BOAT HARBOR RECOVERIES													
No CWTs recovered from small boat harbor				7	4	2	0	0	0	0	0	0	0
Haines marine creel survey total				217	16	121	11	11	10	10	10	259	84

Note: Contribution estimates for wild Chilkat River broods are preliminary until data from all return years are complete and published.

[a] NSRAA = Northern Southeast Regional Aquaculture Association. Release year was 2008 as age-0. smolt.

During June 19–26, creel survey staff sampled 24 Chinook salmon harvested in the Chilkat Inlet subsistence gillnet fishery. The age composition of the samples was 58% (SE = 10%) age 1.2, 25% (SE = 9%) age 1.3, and 17% (SE = 8%) age 1.4 (Appendix C1). The total Chinook salmon harvest reported on 2011 subsistence permits was 97 fish in Chilkat Inlet and 34 fish in the Chilkat River (query on CF Alexander Integrated Fisheries Database[1], June 10, 2013).

Contribution of Coded Wire Tagged Stocks to the 2011 Haines Marine Sport Fishery

Of the 119 Chinook salmon sampled at Letnikof Cove, 11 had clipped adipose fins. Coded wire tags were recovered from 10 of the heads sent to the Tag Lab, and no tag was found in 1 head (Table 12). Estimated contributions to the Chilkat Inlet sport fishery were 43 (SE = 30) BY 2005 Chilkat River Chinook salmon, 183 (SE = 75) BY 2006 Chilkat River Chinook salmon, 22 (SE = 22) BY 2007 Chilkat River Chinook salmon, and 10 (SE = 9) BY 2007 Chinook salmon that originated as smolts released by Northern Southeast Regional Aquaculture Association (NSRAA) in Lutak Inlet in 2008. Neither of the two Chinook salmon sampled at the Haines Small Boat Harbor had a clipped adipose fin. The total contribution of hatchery-origin stocks to the Haines marine sport fishery was 10 (SE = 9) Chinook salmon, all from the Lutak Inlet release site, or 5% of the harvest estimated by the creel survey. The marked fraction of BY 2005 through BY 2007 Chilkat River Chinook salmon used in the contribution estimate is preliminary until the data analysis for each brood year is published.

[1] Statewide electronic fish ticket database (Alexander). Alaska Department of Fish and Game,Division of Commercial Fisheries. 1985 to present. [URL not publicly available, as some information is confidential.]

Table 12.–Results of juvenile Chinook salmon trapping in the Chilkat River drainage in fall 2011 and spring 2012.

Year	Trapping area	Dates	Days fished	Traps set	Number caught	CPUE[a]
2011	Tahini River	Sep. 25–28	4	339	1,840	5.4
2011	Kelsall River	Oct. 3–11	9	828	8,542	10.3
2011	Chilkat River	Oct. 17–28	12	1,212	15,992	13.2
	Fall 2011 subtotal		25	2,379	26,374	11.1
2012	Lower Chilkat River	April 8–May 28	50	4,781	3,187	0.7

[a] Catch per unit of effort expressed as the number of juvenile Chinook salmon caught per minnow trap set.

JUVENILE TAGGING

From September 25 through October 28, 2011, a total of 26,374 Chinook salmon parr from BY 2010 were captured and marked in the Chilkat River drainage (Table 13). The CPUE was highest in the lower Chilkat River and lowest in the Tahini River. The overall fall 2011 CPUE was 11.1 parr/minnow trap. After being held overnight, 14 mortalities were discarded and 0 fish shed their tags, so 26,360 fish were released with valid CWTs and adipose fin clips (Table 14).

Table 13.–Number of brood year 2010 Chinook salmon coded wire tagged (CWT) in the Chilkat River drainage, by area and tag year.

Tag year	Tag code	Sequence range	Location	Last date	Stage	Injected	24h morts	Marked	Shed tags	Valid CWTs released
2011	04-23-99	143–3,306	Tahini River	9/28	Parr	1,840	0	1,840	0	1,840
2011	04-23-99	3,387–17,838	Kelsall River	10/11	Parr	8,542	8	8,534	0	8,534
2011	04-23-99	17,892–45,631	Lower Chilkat R	10/28	Parr	15,992	6	15,986	0	15,986
Fall 2011 subtotal						26,374	14	26,360	0	26,360
2012	04-15-32	Non-sequential	Chilkat River	5/28	Smolt	3,187	12	3,175	0	3,175

During April 8–May 28, 2012, 3,187 Chinook salmon smolts from brood year 2010 were captured and marked in the lower Chilkat River (Table 13). The spring 2012 CPUE was 0.7 smolts/minnow trap. After being held overnight, 12 mortalities were discarded and 0 fish shed their tags, equating to 3,175 fish released with valid head CWTs, second (dorsal) CWTs, and adipose fin clips (Table 14).

A total of 341 Chinook salmon parr were sampled for length during fall 2011, and their mean length was 70 mm FL (SD = 7 mm, Table 15). In spring 2012, 169 smolts were sampled for length and weight. Smolts averaged 73 mm FL (SD = 6 mm) and 4.0 g (SD = 1.3 g).

Table 14.–Mean length and weight of brood year 2010 Chinook salmon smolt in the Chilkat River drainage by trapping location and year.

				Length (mm FL)		
Sample year	Trapping location	Sample dates	Sample size	Range	Mean	SD
2011	Tahini River	Sep. 25–28	80	57–83	72	5
2011	Kelsall River	Oct. 3–11	94	53–90	73	7
2011	Chilkat River	Oct. 17–28	167	55–81	68	6
Fall 2011 subtotal			341	53–90	70	7
2012	Lower Chilkat River	April 10–May 28	169	57–97	73	6
			weight (g)	1.7–9.3	4.0	1.3

Table 15.–Number of brood year 2004 Chinook salmon sampled in the Chilkat River drainage for missing adipose fins, age, and coded wire tags (CWT), by year, and by mainstem gear type or spawning drainage, 2007–2011.

					Wand detector results			Tag Lab results		
Year	Event 1 gear or event 2 tributary	Inspected	Adipose fin-clipped	Clipped fraction	Scanned	Dorsal CWT not detected (Fall)	Dorsal CWT detected (Spring)	Heads examined	Valid CWTs	Head CWT loss fraction
2007	Gillnet	0	0	0.00	–	–	—	–	—	–
2007	Fish wheels	73	12	0.16	11	7	4	11	10	0.09
2008	Gillnet	9	0	0.00	–	–	–	–	–	–
2008	Fish wheels	21	2	0.10	2	0	2	2	2	0.00
2009	Gillnet	40	4	0.10	4	4	0	0	–	–
2009	Fish wheels	32	6	0.19	6	5	1	1	1	0.00
2010	Gillnet	54	7	0.13	7	3	4	0	–	–
2010	Fish wheels	16	2	0.13	2	1	1	0	–	–
2011	Gillnet	1	0	0.00	–	–	–	–	–	–
2011	Fish wheels	0	0	0.00	–	–	–	–	–	–
Event 1 total		246	33	0.13	32	20	12	14	13	0.07
2007	Kelsall River	5	2	0.40	2	0	2	2	2	0.00
2007	Tahini River	11	0	0.00	–	–	–	–	–	–
2007	Klehini River	8	0	0.00	–	–	–	–	–	–
2008	Kelsall River	27	4	0.15	4	2	2	3	3	0.00
2008	Tahini River	59	7	0.12	7	4	3	5	4	0.20
2008	Klehini River	22	3	0.14	3	0	3	3	3	0.00
2009	Kelsall River	45	0	0.00	–	–	–	–	–	–
2009	Tahini River	144	15	0.10	15	12	3	12	11	0.08
2009	Klehini River	26	2	0.08	2	0	2	1	1	0.00
2010	Kelsall River	9	1	0.11	1	1	0	2	2	0.00
2010	Tahini River	95	10	0.11	10	8	2	9	9	0.00
2010	Klehini River	23	3	0.13	3	1	2	1	1	0.00
2011	Kelsall River	3	0	0.00	0	–	–	1	1	0.00
2011	Tahini River	2	0	0.00	–	–	–	–	–	–
2011	Klehini River	0	0	0.00	–	–	–	–	–	–
Event 2 total		479	47	0.10	47	28	19	39	37	0.05
Grand total		725	80	0.110	79	48	31	53	50	0.06
Fraction with head CWT (marine theta)				0.104						

[a] Includes head 343052, recovered from a fish with no age determined from scales.

[b] Includes head 88703, recovered from a fish with no age determined from scales.

[c] Includes head 88726, recovered from a fish with no age determined from scales.

[d] Includes head 88800, recovered from a fish with no age determined from scales.

BROOD YEAR 2004 PRODUCTION

Juvenile Abundance

In fall 2005, 34,696 adipose-finclipped Chinook salmon parr from brood year 2004 were released with CWT codes 041219 and 041215, and in spring 2006, 5,075 adipose-finclipped smolts from the same brood year were released with CWT code 041302: (http://tagotoweb.adfg.state.ak.us/CWT/reports/cwtrelease.asp?). Between 2007 and 2011, 725 adult BY 2004 Chinook salmon were sampled in the Chilkat River for adipose fins, of which 80 were missing adipose fins (Table 16). There was not a significant difference (χ^2 = 1.91, df = 1, P = 0.17) between the fractions of adipose-finclipped fish sampled in the lower river and on the spawning grounds, so the inriver marked fraction ($\theta_{INRIVER}$) for BY 2004 was estimated at 0.110 (SE = 0.012) using pooled lower and upper river data.

Of the 80 adipose-finclipped fish in the escapement from BY 2004 (as determined by scale age), 79 were electronically scanned for head and dorsal CWT presence/absence (Table 16, Appendix D3). Heads were taken from 53 fish and sent to the CF Tag Lab, where 50 CWTs were recovered and decoded, and 3 heads had no CWT. Of the 50 CWTs decoded, 32 were from fall 2005 and 18 were from spring 2006 tagging efforts (Table 17).

In 2004, the first year Chilkat River Chinook salmon were scanned for second CWT presence/absence, the number sampled was small and the error rate was high, so the 2004 results were excluded from historic averages (Table 18). In calendar years 2005–2012, the rate of false positive second CWT detections in fall-tagged fish was not different (χ^2 = 0.02, df = 1, P = 0.88) for large (5 false positive out of 87 scanned) vs. medium/small (6 false positive out of 95 scanned) fish. The rate of false negative second CWT detections of spring-tagged fish was not different (Yates χ^2 = 0.32, df = 1, P = 0.57) for large (4 false negative out of 24 scanned) vs. medium/small (3 false negative out of 39 scanned) fish.

The electronic wand scan results agreed with the Tag Lab's CWT decode results for 45 of 50 fish: there were 4 cases of false positive and 1 case of false negative detection of the second CWT (Appendix D3). The overall false negative rate in fish of all lengths (ω_{f-}) was estimated as 9.9% (SD = 3.5%) and the false positive rate in fish of all lengths (ω_{f+}) was estimated as 5.7% (SD = 1.7%, Appendix E1). Using the decoded CWTs, the false negative and false positive wand results were corrected in further analysis. Of the 79 BY 2004 fish aged and electronically scanned, 48 were assigned fall-tagged status (second CWT absent) and 31 were assigned spring-tagged status (second CWT absent, Table 16).

An estimated 529,700 (SE = 70,150) BY 2004 parr were rearing in the Chilkat River in fall 2005, 23.4% (SE = 4.6%) survived the winter, and 122,800 (SE = 19,820) smolts emigrated from the Chilkat River in spring 2006 (Appendix E1).

Table 16.–Number of brood year 2004 Chilkat River Chinook salmon coded wire tags (CWT) recovered from heads taken in random samples in 2007–2011, by year, area, gear type, and season tagged.

		Purse Seine		Drift GN		Troll		Sport		Chilkat Inlet subsistence		Chilkat River escapement		Fall	Spring	Grand
Year	District	Fall	Spring	Fall	Spring	Fall	Spring	Fall	Spring	Fall	Spring	Fall	Spring	subtotal	subtotal	total
2007	115	0	0	0	0	0	0	0	0	0	0	7	5	7	5	12
2008	114	0	0	0	0	0	1	0	0	0	0	0	0	0	1	1
2008	115	0	0	1	2	0	0	0	0	0	0	4	8	5	10	15
2008 subtotal		0	0	1	2	0	1	0	0	0	0	4	8	5	11	16
2009	108	0	0	1	0	0	0	0	0	0	0	0	0	1	0	1
2009	113	0	0	0	0	1	0	0	0	0	0	0	0	1	0	1
2009	114	0	0	0	0	2	1	0	0	0	0	0	0	2	1	3
2009	115	0	0	0	0	0	0	1	0	0	0	10	3	11	3	14
2009 subtotal		0	0	1	0	3	1	1	0	0	0	10	3	15	4	19
2010	109	0	0	0	0	0	1	0	0	0	0	0	0	0	1	1
2010	113	0	0	0	0	0	0	0	1	0	0	0	0	0	1	1
2010	115	0	0	0	0	0	0	4	1	0	0	10	2	14	3	17
2010 subtotal		0	0	0	0	0	1	4	2	0	0	10	2	14	5	19
2011	115	0	0	0	0	0	0	0	0	0	0	1	0	1	0	1
Grand total		0	0	2	2	3	3	5	2	0	0	32	18	42	25	67

Note: Marine fishery and Chilkat River escapement CWTs were recovered and decoded by Division of Commercial Fisheries Mark, Tag, and Age Laboratory.

Table 17.–Summary of handheld wand scans for second (dorsal) coded wire tag (CWT) presence/absence in brood year 2001 and later adult Chilkat River Chinook salmon, as verified by recovered primary coded wire tag codes, by length category and by sampling calendar year, 2004-2012.

MEF length < 660 mm					
	Fall-tagged fish		Spring-tagged fish		
Calendar year	Correct ID second CWT absent	False positive	Correct ID second CWT present	False negative	Total examined
2004	2	1	0	1	4
2005	16	0	3	0	19
2006	12	0	5	0	17
2007	14	2	9	0	25
2008	11	1	8	0	20
2009	15	1	2	0	18
2010	7	1	3	1	12
2011	18	1	6	1	26
2012	2	0	3	1	6
2005–2012 total	95	6	39	3	143

MEF length ≥ 660 mm					
	Fall-tagged fish		Spring-tagged fish		
Calendar year	Correct ID second CWT absent	False positive	Correct ID second CWT present	False negative	Total examined
2004	0	0	0	0	0
2005	0	0	1	0	1
2006	15	0	3	0	18
2007	3	0	2	0	5
2008	8	0	1	0	9
2009	24	1	7	1	33
2010	15	2	1	1	19
2011	20	2	5	0	27
2012	2	0	4	2	8
2005–2012 total	87	5	24	4	120

All lengths					
2005–2012 total	182	11	63	7	263

Table 18.–Estimated contributions of brood year 2004 Chilkat River Chinook salmon to marine fishery harvests, by year and fishery, 2007–2011.

	Fishery harvest									Contribution		
Fishery	Time[a]	District, quadrant, or port	$\hat{H}$	SE[$\hat{H}$]	*n*	*a*	*a'*	*t*	*t'*	*m*	$\hat{r}$	SE $[\hat{r}]$
2007 recoveries age-1.1												
No BY 2004 Chilkat Chinook salmon CWTs were recovered in 2007 marine fishery random samples.												
2008 recoveries age-1.2												
Troll	TP 2	NW	17,198	0	7,115	502	484	391	389	1	24	24
Drift gillnet	SW 25-33	D 115	499	0	123	15	14	12	12	3	125	72
2008 subtotal										4	149	76
2009 recoveries age-1.3												
Drift gillnet	SW 27	D 108-60	54	0	18	2	2	2	2	1	29	28
Troll	TP 2	NW	15,979	0	7,908	522	519	373	373	4	78	39
Unknown[b]	2009	SE Alaska	1	0	1	1	1	1	1	1	1	0
Haines sport[c]	BW 9–12	D 115–34	33	59	8	1	1	1	1	1	40	39
Haines subsistence[d]	BW 12–14	D 115–32	1	0	1	1	1	1	1	1	1	0
2009 subtotal										8	149	62
2010 recoveries age-1.4												
Troll	TP 2	D 109-62	5,081	0	3,924	434	429	330	330	1	13	12
Sitka sport	2010	Sitka	4,632	770[e]	1,223	81	81	42	42	1	36	36
Haines sport[f]	BW 10-13	D 115–32	145	20	80	9	9	9	9	5	87	40
2010 subtotal										7	136	55
2011 recoveries age-1.5												
No BY 2004 Chilkat Chinook salmon CWTs were recovered in 2011 marine fishery random samples.												
Combined contribution $[\hat{T}]$										19	434	112

Source: Unless otherwise noted, commercial and sport fishery sampling data are from the ADF&G Mark, Tag and Age Laboratory online database at http://tagtoweb.adfg.state.ak.us.

Source: Subsistence fishery harvests are permit reports in Integrated Fisheries Database for Southeast Alaska, maintained by ADF&G/Division of Commercial Fisheries, Region 1, Douglas.

[a] Time values are statistical week (SW), biweek (BW), troll period (TP), or calendar year.

[b] Harvest estimate was not expanded because CWT was recovered with no fishery, time, area, or sampling information.

[c] Sampling data from Chapell (2013a).

[d] Harvest estimate was not expanded from select CWT recovery.

[e] SE estimate from personal communication from Mike Jaenicke, project leader of Northern Southeast AK Creel Survey, ADF&G Division of Sport Fish, Region 1, Douglas.

[f] Sampling data from Chapell (2013b).

Adult Harvest

There were 3 cases of head CWT loss in 53 BY 2004 heads examined by the CF Tag Lab, so θ_{MARINE}, the estimated tagged fraction germane to marine fisheries, was 0.104 (SE = 0.012, Table 16). Seventeen BY 2004 Chilkat River Chinook salmon were recovered through random sampling in marine commercial, sport, and subsistence fisheries from 2007 to 2011 (Table 17, Figure 6, Appendix D1). An estimated 434 (SE = 112) BY 2004 Chilkat River Chinook salmon were harvested in sampled marine fisheries between 2007 and 2011 (Table 19). Harvest-at-age was 149 (SE = 76) age-1.2, 149 (SE = 64) age-1.3, and 136 (SE = 552) age-1.4 fish. The commercial fishery sector had the largest share (62%) of the total harvest of BY 2004 Chilkat River Chinook salmon, followed by the sport (38%) and the subsistence (0.2%) fishery sectors (Table 20). The specific fisheries with the largest share of the Chilkat harvest were the Haines sport (29%), Lynn Canal commercial gillnet (29%), and Southeast Alaska commercial troll (27%) fisheries.

Marine Exploitation and Survival

Based upon a total inriver return of 3,283 (SE = 435) age-1.2 and older BY 2004 Chilkat River Chinook salmon and a total marine harvest of 434 (SE = 112) age-1.2 and older fish, the total age-1.2 and older return was 3,717 (SE = 450) fish (Table 21). The estimated smolt-to-age marine survival rate for age 1.2 and older was 3.0% (SE = 0.6%). The estimated marine exploitation rate for this stock was 11.7% (SE = 3.0%).

DATA FILES

Data collected during this study have been archived in ADF&G offices in Haines, Douglas, and Anchorage (Appendix G1).

Table 19.–Total marine harvest and estimated contribution of brood year 2004 Chilkat River Chinook salmon, by fishery and area, 2007–2011.

Fishery	Area	Total fishery harvest	Chilkat harvest	SE	Chilkat percent of fishery	Percent of total Chilkat harvest
Commercial fishery						
Troll	Quad. NW	38,258	115	47	0.3	26.5
Drift gillnet	Dist. 108	54	29	28	53.4	6.6
Drift gillnet	Dist. 115	499	125	72	25.1	28.9
Unknown[a]	SE Alaska	1	1	0	100.0	0.2
	Subtotal	38,812	270	91	0.7	62.2
Sport fishery						
	Sitka	4,632	36	36	0.8	8.4
	Haines	178	127	56	71.2	29.2
	Subtotal	4,810	163	67	3.4	37.6
Subsistence fishery						
	Chilkat Inlet[a]	1	1	0	100.0	0.2
Grand total		43,623	434	112	1.0	100.0

[a] Harvest estimate was not expanded from select CWT recovery.

Table 20.–Estimated stock assessment parameters for brood year 2004 Chilkat River Chinook salmon.

Parameter	Estimate	SE
2005 fall parr abundance	529,700	70,150 [a]
2005–2006 overwinter survival	0.234	0.046 [a]
2006 spring smolt abundance	122,800	19,820 [a]
Marine harvest (age 1.2 and older)	434	112
Inriver return (age 1.2 and older)	3,283	435
Total return (age 1.2 and older)	3,717	450
Marine exploitation rate (age 1.2 and older)	0.117	0.030
Smolt survival to age 1.2 and older	0.030	0.006

[a] Standard deviation of the posterior distribution, which is a measure of spread analogous to standard error.

DISCUSSION

Several assumptions, as noted above, underlie the mark-recapture estimate of inriver abundance. Considerable efforts were made to catch and mark fish in proportion to their abundance (assumption a) by sampling uniformly across the escapement. Also, sampling effort for tag recovery on the Kelsall and Tahini rivers (where 85% of spawning occurred in 2005 and >90% occurred in 1991 and 1992; Ericksen and Chapell 2006; Johnson et al. 1992, 1993) was fairly constant across the time when fish were accessible to sampling. Carcass retrievals, which can be sex selective in some situations (Pahlke et al. 1996; McPherson et al. 1997; Zhou 2002; Miyakoshi et al. 2003), comprised 35% of the spawning ground samples. Using other capture methods (34% gillnet, 30% snagging, 1% dipnet) on the spawning grounds reduced the potential bias that may be inherent in any one method. The assumption (b) of no recruitment during the experiment is reasonable because tagging effort was relatively constant and continued until only about 1 fish per day was being caught. Assumption (c), that marking does not affect catchability of fish, was tested in the 2005 radiotelemetry study where 2.3% or less of tagged fish failed to make significant upstream progress after tagging (Ericksen and Chapell 2006).

Assumptions (d), that marks were not lost, and (e), that recaptured fish were detected and reported, were satiSFied by applying the secondary mark (ULOP). Assumption (f), no duplicate sampling, was satiSFied by applying the ULOP in event 1 and LLOP in event 2. Only fish with intact left opercula were considered in events 1 and 2.

The 2011 inriver run of 2,688 (SE = 268) large Chinook salmon was within the inriver run goal range (1,850 to 3,600 large Chinook salmon) specified in the Lynn Canal and Chilkat River King Salmon Fishery Management Plan (5 AAC 33.384; Table 22). Since the mark-recapture inriver run estimation project was started in 1991, the inriver run fell short of the goal in 2 years: 2007 and 2010 (Figure 7). After subtracting the estimated 14 large fish removed by the inriver subsistence fishery, the estimated escapement was 2,674 large fish, which is within the Chilkat River Chinook salmon BEG range of 1,750 to 3,500 large fish (Table 22). The inriver subsistence fishery removal was calculated by applying the proportion of large (age-1.3 and older) fish (0.42) in the 2011 Chilkat Inlet subsistence gillnet samples to the total inriver harvest (34 fish) reported on 2011 permits.

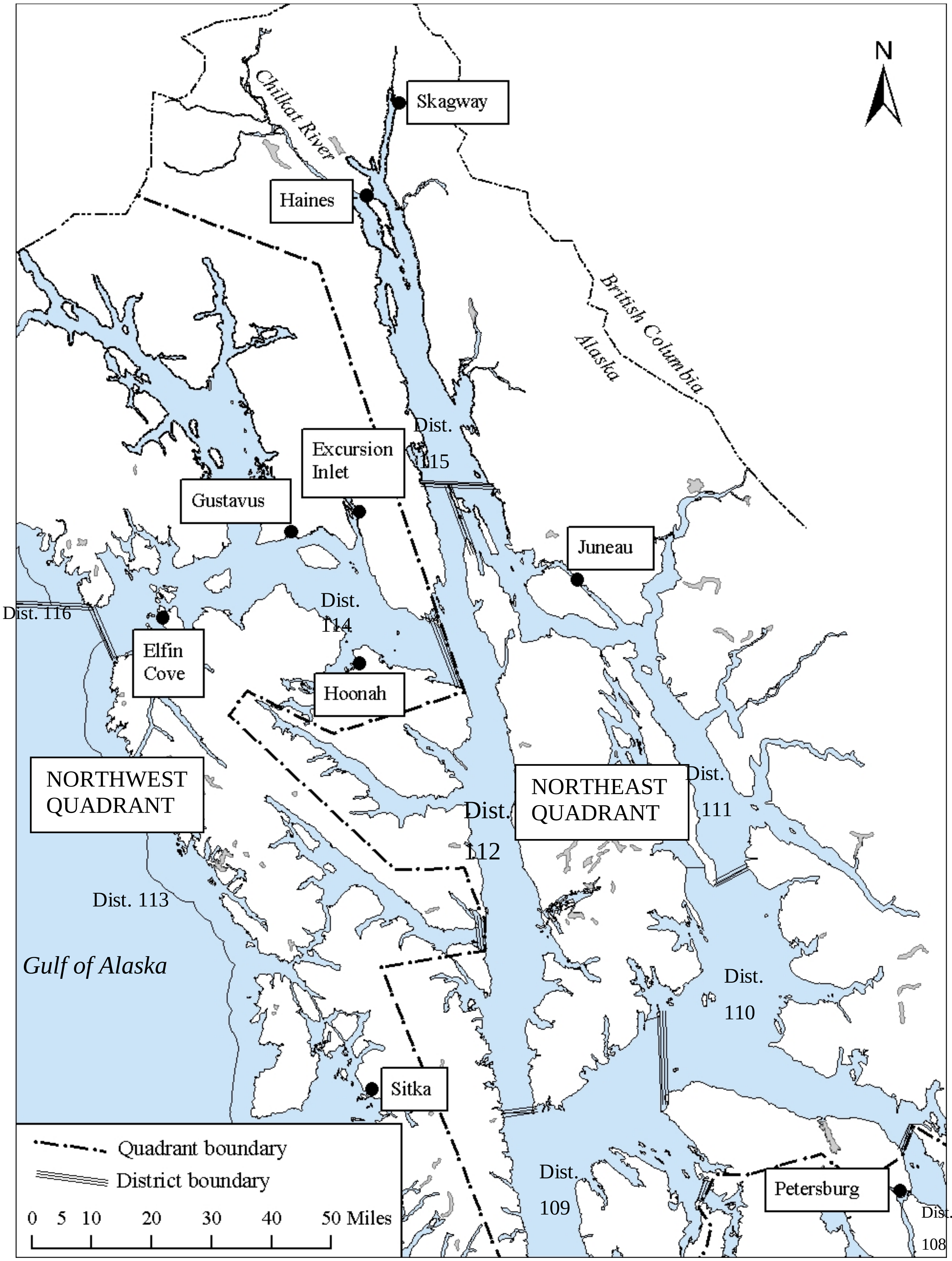

Figure 6.–Commercial and sport fishery quadrants, districts, and sampling ports in northern Southeast Alaska.

Table 21.–Estimated annual inriver run by age of medium (age-1.2) and large (≥ age-1.3) Chilkat River Chinook salmon, annual large escapement estimates, 1991–2011, and estimated marine harvest and total return by age class of fish from coded wire tagged brood years 1988, 1989, 1991, 1998–2004.

Calendar year		1.2	(SE)	1.3	(SE)	1.4	(SE)	1.5	(SE)	Inriver run total	(SE)	Large (≥ age 1.3) inriver subsistence harvest	Large (≥ age 1.3) escapement
1991	Inriver run[a]	817	(139)	3,211	(558)	2,563	(445)	123	(18)	6,714	(727)	14[b]	5,883
	Marine harvest	ND	ND	ND	ND	ND	ND	ND	ND				
	Total return	ND	ND	ND	ND	ND	ND	ND	ND				
1992	Inriver run[c]	560	(100)	1,689	(304)	3,595	(649)	0	(0)	5,844	(723)	7[b]	5,277
	Marine harvest[d]	459	(166)	ND	ND	ND	ND	ND	ND				
	Total return	1,019	(194)	ND	ND	ND	ND	ND	ND				
1993	Inriver run[e]	551	(104)	2,217	(424)	2,180	(425)	75	(10)	5,023	(582)	8[b]	4,464
	Marine harvest[f]	134	(50)	572	(208)	ND	ND	ND	ND				
	Total return	685	(115)	2,789	(472)	ND	ND	ND	ND				
1994	Inriver run[g]	184	(28)	2,565	(405)	4,148	(657)	82	(10)	6,979	(773)	2[b]	6,793
	Marine harvest	ND	ND	415	(123)	605	(302)	ND	ND				
	Total return	ND	ND	2,980	(423)	4,753	(723)	ND	ND				
1995	Inriver run[h]	1,384	(295)	530	(111)	3,074	(660)	186	(37)	5,174	(733)	12[b]	3,778
	Marine harvest[i]	286	(129)	ND	ND	134	(74)	2	(1)				
	Total return	1,670	(322)	ND	ND	3,208	(664)	188	(37)				
1996	Inriver run[j]	398	(60)	4,140	(639)	737	(112)	43	(5)	5,318	(652)	10[b]	4,910
	Marine Harvest	ND	ND	459	(129)	ND	ND	0	(0)				
	Total Return	ND	ND	4,599	(652)	ND	ND	43	(5)				
1997	Inriver run[k]	160	(48)	1,943	(354)	6,157	(930)	0	(0)	8,260	(997)	5[b]	8,095
	Marine harvest	ND	ND	ND	ND	260	(104)	ND	ND				
	Total return	ND	ND	ND	ND	6,417	(936)	ND	ND				

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Calendar year		1.2	(SE)	1.3	(SE)	1.4	(SE)	1.5	(SE)	Inriver run total	(SE)	Large (≥ age 1.3) inriver subsistence harvest	Large (≥ age 1.3) escapement
1998	Inriver run[l]	226	(54)	1,016	(169)	2,440	(381)	219	(48)	3,901	(423)	18[b]	3,657
	Marine harvest	ND	ND	ND	ND	ND	ND	1	0				
	Total return	ND	ND	ND	ND	ND	ND	220	(48)				
1999	Inriver run[m]	427	(94)	534	(109)	1,656	(302)	80	(27)	2,698	(336)	12[b]	2,258
	Marine harvest	ND	ND	ND	ND	ND	ND	ND	ND				
	Total return	ND	ND	ND	ND	ND	ND	ND	ND				
2000	Inriver run[n]	629	(122)	1,350	(227)	653	(118)	32	(14)	2,664	(283)	6[o]	2,029
	Marine harvest	ND	ND	ND	ND	ND	ND	ND	ND				
	Total return	ND	ND	ND	ND	ND	ND	ND	ND				
2001	Inriver run[p]	755	(209)	2,529	(376)	1,988	(617)	0	(0)	5,272	(752)	3[o]	4,514
	Marine harvest	ND	ND	ND	ND	ND	ND	ND	ND				
	Total return	ND	ND	ND	ND	ND	ND	ND	ND				
2002	Inriver run[q]	373	(123)	2,353	(312)	1,667	(294)	30	(19)	4,423	(446)	16[o]	4,034
	Marine harvest[r]	0	(0)	ND	ND	ND	ND	ND	ND				
	Total return	373	(123)	ND	ND	ND	ND	ND	ND				
2003	Inriver run[s]	1,267	(293)	1,833	(362)	3,783	(582)	41	(29)	6,924	(746)	26[o]	5,631
	Marine harvest[t]	505	(373)	688	(687)	ND	ND	ND	ND				
	Total return	1,772	(474)	2,521	(777)	ND	ND	ND	ND				
2004	Inriver run[u]	1,361	(492)	1,999	(333)	1,379	(303)	44	(17)	4,783	(667)	16[o]	3,406
	Marine harvest[v]	493	(172)	795	(190)	352	(249)	ND	ND				
	Total Return	1,854	(519)	2,794	(383)	1,731	(392)	ND	ND				
2005	Inriver run[w]	1,597	(620)	1,857	(433)	1,498	(347)	11	(8)	4,963	(831)	5[o]	3,361
	Marine harvest[x]	234	(114)	383	(105)	244	(75)	0	(0)				
	Total return	1,831	(630)	2,240	(446)	1,742	(353)	11	(8)				

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Calendar year		1.2	(SE)	1.3	(SE)	1.4	(SE)	1.5	(SE)	Inriver run total	(SE)	Large (≥ age 1.3) inriver subsistence harvest	Large (≥ age 1.3) escapement
2006	Inriver run[y]	260	(81)	2,084	(333)	955	(185)	0	(0)	3,299	(488)	36[o]	3,003
	Marine harvest[z]	95	(53)	331	(121)	114	(63)	28	(334)				
	Total return	355	(97)	2,415	(354)	1,069	(195)	28	(334)				
2007	Inriver run[aa]	602	(138)	585	(136)	860	(182)	0	(0)	2,047	(266)	7[o]	1,438
	Marine harvest[ab]	385	(161)	233	(71)	255	(146)	0	(0)				
	Total return	987	(212)	818	(153)	1,115	(233)	0	(0)				
2008	Inriver run[ac]	665	(243)	2,153	(417)	732	(173)	21	(21)	3,570	(513)	24[o]	2,882
	Marine harvest[ad]	149	(76)	305	(114)	52	(29)	0	(0)				
	Total return	814	(255)	2,458	(432)	784	(175)	21	(21)				
2009	Inriver run[ae]	1,445	(286)	1,678	(322)	2,751	(489)	0	(0)	5,874	(652)	23[o]	4,406
	Marine harvest	NA	NA	149	(62)	435	(112)	0	(0)				
	Total return	NA	NA	1,827	(328)	3,186	(502)	0	(0)				
2010	Inriver run[af]	477	(100)	874	(156)	927	(163)	13	(13)	2,292	(247)	18[o]	1,797
	Marine harvest	NA	NA	NA	NA	136	(55)	0	(0)				
	Total return	NA	NA	NA	NA	1,063	(172)	13	(0)				
2011	Inriver run[ag]	1,275	(176)	1,830	(233)	846	(131)	13	(13)	3,963	(320)	14[o]	2,674
	Marine harvest	NA	NA	NA	NA	NA	NA	0	(0)				
	Total return	NA	NA	NA	NA	NA	NA	13	(0)				

-continued-

Table 22.–Page 4 of 4.

Note: ND = no data; this brood year was not CWT tagged.

Note: NA = data not available at time of publication.

[a] Inriver run data from Johnson et al. (1992).

[b] Annual inriver subsistence harvest as reported in CF Alexander database, multiplied by the 2000-2008 average of annual large (≥age-1.3) proportions of Chilkat Inlet subsistence gillnet samples (Appendix C2).

[c] Inriver run data from Johnson et al. (1993).

[d] Brood year 1988 marine harvest data from Ericksen (1996).

[e] Inriver run data from Johnson (1994).

[f] Brood year 1989 marine harvest data from Ericksen (1996).

[g] Inriver run data from Ericksen (1995).

[h] Inriver run data from Ericksen (1996).

[i] Brood year 1991 marine harvest data from Ericksen (1999).

[j] Inriver run data from Ericksen (1997).

[k] Inriver run data from Ericksen (1998).

[l] Inriver run data from Ericksen (1999).

[m] Inriver run data from Ericksen (2000).

[n] Inriver run data from Ericksen (2001).

[o] Annual inriver subsistence harvest as reported in CF Alexander database, multiplied by the annual large (≥age-1.3) proportion of Chilkat Inlet subsistence gillnet samples (Appendix C2).

[p] Inriver run data from Ericksen (2002-a).

[q] Inriver run data from Ericksen (2003).

[r] Brood year 1998 marine harvest data from Ericksen (2006).

[s] Inriver run data from Ericksen (2004).

[t] Brood year 1999 marine harvest data from Chapell (2009).

[u] Inriver run data from Ericksen (2005).

[v] Brood year 2000 marine harvest data from Chapell (2010).

[w] Inriver run data from Ericksen and Chapell (2006).

[x] Brood year 2001 marine harvest data from Chapell (2012).

[y] Inriver run data from Chapell (2009).

[z] Brood year 2002 marine harvest data from Chapell (2013).

[aa] Inriver run data from Chapell (2010).

[ab] Brood year 2003 marine harvest data from Chapell (*In press*)

[ac] Inriver run data from Chapell (2012).

[ad] Brood year 2004 marine harvest data from Table 19.

[ae] Inriver run data from Chapell (2013a).

[af] Inriver run data from Chapell (2013b).

[ag] Inriver run data from Table 8.

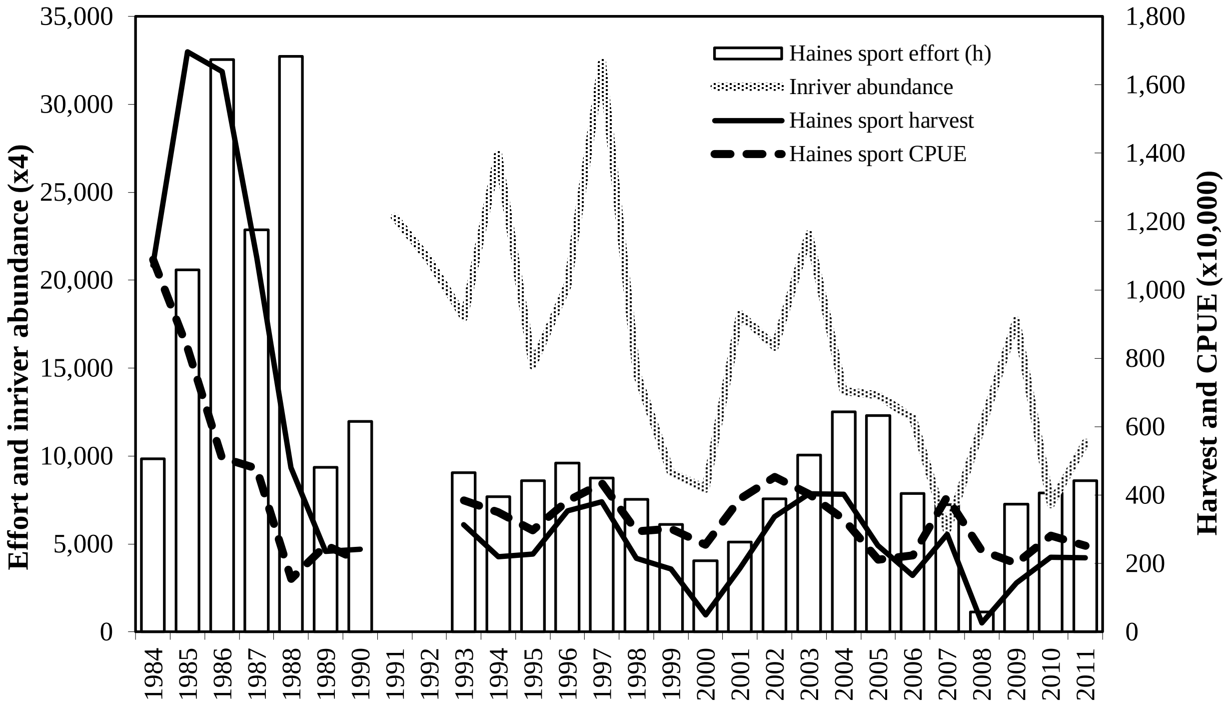

Figure 7.–Estimated angler effort, harvest, and CPUE of large (≥28 inches TL) Chinook salmon in the Haines spring marine boat sport fishery, 1984–2011, and estimated inriver run of large (≥age 1.3) Chinook salmon in the Chilkat River, 1991–2011.

Source: Tables 1 and 22.

Note: The Chilkat Inlet Chinook salmon sport fishery was closed in 1991, 1992, and 2008.

Each fall in 2000–2011, an average of 27,800 Chilkat River Chinook salmon parr have been marked with CWTs (brood years 1999–2012). Using the 31% average overwinter survival rate for BY 1999–2004, the fall marking effort has produced approximately 8,700 CWT-marked smolts each spring (Appendix F1). Spring 2001–2013 tagging efforts have produced an average of 4,065 CWT-tagged smolts from BY 1999–2011. The average CWT-marked fraction for BY 1999–2004 was 9.8%. The high number of marked fish has allowed the harvest of BY 1999 and later Chilkat River Chinook salmon to be tracked with high resolution. The fall and spring tagging efforts should be continued to monitor harvest of the relatively small Chilkat River Chinook salmon stock in nearby hatchery release terminal harvest areas (Lutak Inlet, Taiya Inlet) where up to 500,000 hatchery-reared Chinook salmon smolts have been released annually (Figure 1; ADF&G 2013).

Using nonlethal escapement sampling methods (handheld wand scan to detect secondary CWT presence-absence, paired with scale age) has benefitted production of the relatively small Chilkat Chinook salmon stock. Twenty seven (27) large (≥age 1.3) adipose-finclipped pre-spawners from BY 2004 were sampled and released (Appendix D3). However, the nonlethal method added uncertainty to parameter estimates due to the 7% error rate in detecting the second CWT (sampling in calendar years 2005–2012, Table 18). When only sacrificed fish and decoded CWTs were considered in the BY 2004 CWT analysis, the juvenile abundance estimates were similar, with overlapping 95% CI, but the CI was much wider for the sacrificed fish results (Appendix E2). The added uncertainty from nonlethal sampling was outweighed by the larger sample size. Continued training of escapement sampling staff to avoid magnetized items in the sample proximity and to carefully scan large fish, is needed to minimize handheld wand scan errors.

Sacrificing some adipose-finclipped fish from the escapement is necessary to monitor false negative/false positive wand detector error, tag loss, and straying. The wand detector method cannot distinguish between secondary CWT tag loss and a false negative result, so these two errors were treated as the same in the data analysis. False negative and false positive detection rates are factored into the WinBUGS model and will be updated with additional years of tag code-verified wand results when available in an effort to produce bias-free estimates. Stray Chinook salmon were not found in the 434 CWTs decoded during Chilkat River escapement sampling in 2001–2012 (Noncommercial survey site = Chilkat; http://tagotoweb.adfg.state.ak.us/CWT/reports/).

The BY 2004 smolt production (122,800) was the second lowest out of the 7 brood years for which this parameter has been estimated (Appendix F1). Saltwater survival of this brood was slightly below average for these 7 brood years. Net production, as measured by total return, was the second lowest since estimated for the Chilkat Chinook salmon stock.

Below average juvenile CPUE in minnow traps may indicate below average abundance of BY 2010 Chilkat River Chinook salmon. The fall 2011 CPUE (11.1 parr/minnow trap) was lower than the 13.4 parr/trap average of 2000–2010 fall efforts. The spring 2012 CPUE (0.7 smolt/minnow trap) was below the 2001–2011 spring effort average (1.0 smolt/trap).

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APPENDIX A

Appendix A1.–Detection of size or sex selective sampling during a 2-sample mark–recapture experiment and recommended procedures for estimating population size and population composition.

Size selective sampling: The Kolmogorov-Smirnov two sample test (Conover 1980) is used to detect size-selective sampling during the first or second sampling events. The second sampling event is evaluated by comparing the length frequency distribution of all fish marked during the first event (M) with that of marked fish recaptured during the second event (R), using the null test hypothesis of no difference. The first sampling event is evaluated by comparing the length frequency distribution of all fish inspected for marks during the second event (C) with that of R. A third test, comparing M and C, is conducted and used to evaluate the results of the first two tests when sample sizes are small. Guidelines for small sample sizes are <30 for R and <100 for M or C.

Sex selective sampling: Contingency table analysis (Chi^2-test) is used to detect sex-selective sampling during the first or second sampling events. The counts of observed males to females are compared between M&R, C&R, and M&C as described above, using the null hypothesis that the probability that a sampled fish is male or female is independent of sample. When the proportions by gender are estimated for a sample (usually C), rather an observed for all fish in the sample, contingency table analysis is not appropriate and the proportions of females (or males) are compared between samples using a two sample test (e.g., Student's t-test).

M versus R	C versus R	M versus C
Case I:		
Fail to reject H_o	Fail to reject H_o	Fail to reject H_o
There is no size/sex selectivity detected during either sampling event.		
Case II:		
Reject H_o	Fail to reject H_o	Reject H_o
There is no size/sex selectivity detected during the first event but there is during the second event sampling.		
Case III:		
Fail to reject H_o	Reject H_o	Reject H_o
There is no size/sex selectivity detected during the second event but there is during the first event sampling.		
Case IV:		
Reject H_o	Reject H_o	Reject H_o
There is size/sex selectivity detected during both the first and second sampling events.		
Evaluation Required:		
Fail to reject H_o	Fail to reject H_o	Reject H_o

Sample sizes and powers of tests must be considered:

A. If sample sizes for M versus R and C versus R tests are not small and sample sizes for M versus C test are very large, the M versus C test is likely detecting small differences which have little potential to result in bias during estimation. *Case I* is appropriate.

B. If a) sample sizes for M versus R are small, b) the M versus R p-value is not large (~0.20 or less), and c) the C versus R sample sizes are not small and/or the C versus R p-value is fairly large (~0.30 or more), the rejection of the null in the M versus C test was likely the result of size/sex selectivity during the second event which the M versus R test was not powerful enough to detect. *Case I* may be considered but *Case II* is the recommended, conservative interpretation.

-continued-

C. If a) sample sizes for C versus R are small, b) the C versus R p-value is not large (~0.20 or less), and c) the M versus R sample sizes are not small and/or the M versus R p-value is fairly large (~0.30 or more), the rejection of the null in the M versus C test was likely the result of size/sex selectivity during the first event which the C versus R test was not powerful enough to detect. *Case I* may be considered but *Case III* is the recommended, conservative interpretation.

D. If a) sample sizes for C versus R and M versus R are both small, and b) both the C versus R and M versus R p-values are not large (~0.20 or less), the rejection of the null in the M versus C test may be the result of size/sex selectivity during both events which the C versus R and M versus R tests were not powerful enough to detect. *Cases I, II, or III* may be considered but *Case IV* is the recommended, conservative interpretation.

Case I. Abundance is calculated using a Petersen-type model from the entire data set without stratification. Composition parameters may be estimated after pooling length, sex, and age data from both sampling events.

Case II. Abundance is calculated using a Petersen-type model from the entire data set without stratification. Composition parameters may be estimated using length, sex, and age data from the first sampling event without stratification. If composition is estimated from second event data or after pooling both sampling events, data must first be stratified to eliminate variability in capture probability (detected by the M versus R test) within strata. Composition parameters are estimated within strata, and abundance for each stratum needs to be estimated using a Petersen-type formula. Overall composition parameters are estimated by combining stratum estimates weighted by estimated stratum abundance according to the formulae below.

Case III. Abundance is calculated using a Petersen-type model from the entire data set without stratification. Composition parameters may be estimated using length, sex, and age data from the second sampling event without stratification. If composition is estimated from first event data or after pooling both sampling events, data must first be stratified to eliminate variability in capture probability (detected by the C versus R test) within strata. Composition parameters are estimated within strata, and abundance for each stratum needs to be estimated using a Petersen-type type formula. Overall composition parameters are estimated by combining stratum estimates weighted by estimated stratum abundance according to the formulae below.

Case IV. Data must be stratified to eliminate variability in capture probability within strata for at least one or both sampling events. Abundance is calculated using a Petersen-type model for each stratum, and estimates are summed across strata to estimate overall abundance. Composition parameters may be estimated within the strata as determined above, but only using data from sampling events where stratification has eliminated variability in capture probabilities within strata. If data from both sampling events are to be used, further stratification may be necessary to meet the condition of capture homogeneity within strata for both events. Overall composition parameters are estimated by combining stratum estimates weighted by estimated stratum abundance.

If stratification by sex or length is necessary, overall composition is estimated by combining within-stratum composition estimates as follows:

$$\hat{p}_k = \sum_{i=1}^{j} \frac{\hat{N}_i}{\hat{N}_\Sigma} \hat{p}_{ik} \text{, and} \qquad (1)$$

$$\hat{V}[\hat{p}_k] \approx \frac{1}{\hat{N}_\Sigma^2} \left(\sum_{i=1}^{j} \hat{N}_i^2 \hat{V}[\hat{p}_{ik}] + \left(\hat{p}_{ik} - \hat{p}_k \right)^2 \hat{V}[\hat{N}_i] \right) \qquad (2)$$

where:

	j	=	the number of sex/size strata;
	$\hat{p}_{ik}$	=	the estimated proportion of fish that were age or size *k* among fish in stratum *i*;
	$\hat{N}_i$	=	the estimated abundance in stratum *i*;
	$\hat{N}_\Sigma$	=	sum of the $\hat{N}_i$ across strata.

APPENDIX B

Appendix B1.–Biweekly sampling statistics and estimated effort, catch, and harvest of large (≥28 in TL) and small (<28 in TL) Chinook salmon at Letnikof Cove boat launch, May 9–June 26, 2011.

		May 23–June 5				
	May 9–May 22	Non-derby	Derby	June 6–June 19	June 20–June 26	Total
Boats counted	52	26	118	121	25	342
Angler-hr. sampled	406	256	3,562	1,120	194	5,538
Salmon-hr. sampled	389	256	3,557	1,118	194	5,514
Chinook sampled	0	10	79	26	4	119
Sampled for ad-clips	0	10	79	27	4	119
Adipose clips	0	1	7	3	0	11
Angler-hours						
Estimate	546	674	3,707	1,986	482	7,395
Variance	8,648	23,434	38,247	41,270	50,306	161,905
Salmon-hours						
Estimate	530	674	3,698	1,979	482	7,363
Variance	8,648	23,434	36,697	40,377	50,306	159,462
Large Chinook catch						
Estimate	0	33	91	74	14	212
Variance	0	135	58	44	0	234
Large Chinook harvest						
Estimate	0	33	91	74	14	212
Variance	0	135	58	44	0	234
Wild mature Chinook harvest (excluding hatchery and immature fish)						
Estimate	0	27	64	69	14	174
Variance	0	84	19	70	0	172
Small Chinook catch						
Estimate	2	0	138	239	95	474
Variance	0	0	3,671	1,394	3,089	8,154
Small Chinook harvest						
Estimate	0	0	0	0	0	0
Variance	0	0	0	0	0	0

Note: Harvest of small Chinook salmon was not allowed in the Haines area in 2011.

Appendix B2.–Biweekly sampling statistics and estimated effort, catch, and harvest of large (≥28 in TL) and small (<28 in TL) Chinook salmon at Chilkat State Park boat launch during the Haines King Salmon Derby, May 28–30 and June 4–5, 2011.

	May 28-30 & June 4-5	
	Derby	Total
Boats counted	2	2
Angler-hr. sampled	39	39
Salmon-hr. sampled	39	39
Chinook sampled	0	0
Sampled for adipose clips	0	0
Adipose clips	0	0
Angler-hours		
Estimate	120	120
Variance	11,520	11,520
Salmon-hours		
Estimate	120	120
Variance	11,520	11,520
Large Chinook catch		
Estimate	0	0
Variance	0	0
Large Chinook harvest		
Estimate	0	0
Variance	0	0
Wild mature Chinook harvest (excluding hatchery and immature fish)		
Estimate	0	0
Variance	0	0
Small Chinook catch		
Estimate	0	0
Variance	0	0
Small Chinook harvest		
Estimate	0	0
Variance	0	0

Note: Harvest of small Chinook salmon was not allowed in the Haines area in 2011.

Appendix B3.–Biweekly sampling statistics and estimated effort, catch, and harvest of large (≥28 in TL) and small (<28 in TL) Chinook salmon at the Haines Small Boat Harbor, May 9–June 26, 2011.

		May 23–June 5				
	May 9–May 22	Non-derby	Derby	June 6–June 19	June 20–June 26	Total
Boats counted	7	6	5	14	10	42
Angler-hr. sampled	48	60	37	113	126	384
Salmon-hr. sampled	40	60	37	104	108	349
Chinook sampled	0	1	0	0	1	2
Sampled for adipose clips	0	1	0	0	1	2
Adipose clips	0	0	0	0	0	0
Angler-hours						
Estimate	221	271	185	319	227	1,223
SE	8,876	11,624	19,220	11,045	4,115	54,880
Salmon-hours						
Estimate	184	271	185	287	185	1,112
SE	7,781	11,624	19,220	8,575	3,985	51,185
Large Chinook catch						
Estimate	0	5	0	0	2	7
SE	0	16	0	0	3	19
Large Chinook harvest						
Estimate	0	5	0	0	2	7
SE	0	16	0	0	3	19
Wild mature Chinook harvest (excluding hatchery and immature fish)						
Estimate	0	0	0	0	0	0
SE	0	0	0	0	0	0
Small Chinook catch						
Estimate	0	0	0	57	28	85
SE	0	0	0	811	118	929
Small Chinook harvest						
Estimate	0	0	0	0	0	0
SE	0	0	0	0	0	0

Note: Harvest of small Chinook salmon was not allowed in the Haines area in 2011.

APPENDIX C

Appendix C1.–Estimated age composition and mean length-at-age (mm MEF) of Chinook salmon incidentally harvested in the Chilkat Inlet subsistence gillnet fishery, June 19–July 3, 2011.

		Brood year and age class						
		2008	2007	2006	2005	2004	Total	Total
		1.1	1.2	1.3	1.4	1.5	aged	sampled
Females	Sample size	0	2	4	2	0	8	8
	Proportion		0.25	0.50	0.25			1.00
	SE		0.16	0.19	0.16			
	Mean length		605	753	870			
	SE		64	36				
Males	Sample size	0	12	2	2	0	16	16
	Proportion		0.75	0.13	0.13			1.00
	SE		0.11	0.09	0.09			
	Mean length		534	655	860			
	SE		37	7	14			
Total	Sample size	0	14	6	4	0	24	24
	Proportion		0.58	0.25	0.17			1.00
	SE		0.10	0.09	0.08			
	Mean length		544	720	865			
	SE		46	58	19			

Appendix C2.–Estimated age composition of Chinook salmon incidentally harvested in the Chilkat Inlet subsistence gillnet fishery, 2000–2011.

	Number	Percent by age class					
Year	aged	1.1	1.2	1.3	1.4	1.5	Large (≥age-1.3) total
2000[a]	15	0.0	60.0	26.7	13.3	0.0	40.0
2001[b]	20	0.0	35.0	55.0	10.0	0.0	65.0
2002[c]	23	0.0	21.7	52.2	26.1	0.0	78.3
2003[d]	33	3.1	48.5	27.3	21.2	0.0	48.5
2004[e]	38	5.2	31.6	47.4	15.8	0.0	63.2
2005[f]	21	0.0	38.1	33.3	28.6	0.0	62.4
2006[g]	21	0.0	9.5	66.7	23.8	0.0	90.5
2007[h]	11	9.1	36.4	27.3	27.3	0.0	54.6
2008[i]	13	7.7	23.1	53.8	15.4	0.0	69.2
2009[j]	11	0.0	45.5	27.3	27.3	0.0	54.5
2010[k]	9	0.0	55.6	33.3	11.1	0.0	44.4
2011[l]	24	0.0	58.3	25.0	16.7	0.0	41.7
2000-2007 Average	20	0.2	35.1	42.0	20.8	0.0	62.8

[a] Data from Ericksen (2001).
[b] Data from Ericksen (2002).
[c] Data from Ericksen (2003).
[d] Data from Ericksen (2004).
[e] Data from Ericksen (2005).
[f] Data from Ericksen and Chapell (2006).
[g] Data from Chapell (2009).
[h] Data from Chapell (2010).
[i] Data from Chapell (2012).
[j] Data from Chapell (2013a).
[k] Data from Chapell (2013b).
[l] Data from Appendix C1.

APPENDIX D

Appendix D1.–Brood year 2004 Chilkat Chinook salmon coded wire tags recovered from marine fisheries, 2007–2011.

Year	Head	Tag code	Gear	Survey site	Recovery date	Stat wk	Quadrant	Dist	Subdist	Length
Random sampling recoveries										
2008	354046	41302	Troll	Hoonah	6/22/2008	26	NW	114	25	707
2008	529662	41302	Drift	Exc. Inlet	6/15/2008	25	NE	115	10	500
2008	529657	41302	Drift	Exc. Inlet	6/15/2008	25	NE	115	10	580
2008	540753	41219	Drift	Exc. Inlet	8/11/2008	33	NE	115	ND	570
2009	343612	41219	Troll	Hoonah	6/16/2009	25	NW	113	95	766
2009	355198	41219	Troll	Hoonah	5/13/2009	20	NW	114	50	747
2009	253306	41219	Troll	Elfin Cove	5/20/2009	21	NW	114	50	775
2009	253302	41302	Troll	Elfin Cove	5/20/2009	21	NW	114	50	775
2009	306105	41219	Drift	Petersburg	6/30/2009	27	SE	108	60	585
2009	343044	41219	Sport	Haines	6/14/2009	25	NE	115	34	625
2010	366502	41302	Troll	Sitka	5/13/2010	20	NE	109	62	675
2010	533361	41302	Sport	Sitka	5/30/2010	23	NE	113	ND	810
2010	88602	41219	Sport	Haines	5/30/2010	23	NE	115	32	870
2010	88605	41219	Sport	Haines	6/5/2010	23	NE	115	32	965
2010	88607	41219	Sport	Haines	6/17/2010	25	NE	115	32	800
2010	88608	41219	Sport	Haines	6/17/2010	25	NE	115	32	840
2010	88609	41302	Sport	Haines	6/18/2010	25	NE	115	32	890
Select and voluntary recoveries										
2009	254138	41219	Subsistence	Haines	7/4/2009	27	NE	115	32	810
2009	997510	41302	Unknown	Unknown	Unknown		Unknown			

Note: No brood year 2004 heads were recovered in 2007 or 2011 marine sampling efforts.

Appendix D2.–Comparison of handheld wand detection of second (dorsal) coded wire tag (CWT) presence/absence with tag codes in 267 adipose-finclipped adult Chinook salmon examined in the Chilkat River escapement, calendar years 2004–2012.

Calendar year	Brood year	Site	Head number	Length (mm MEF)	Tag code	Season tagged	Second CWT present
2004	2001	Lower Chilkat	254,003	390	40453	Spring	No[a]
2004	2001	Kelsall	254,123	405	40553	Fall	Yes[a]
2004	2001	Kelsall	254,124	340	40553	Fall	No
2004	2001	Kelsall	254,125	380	40553	Fall	No
2005	2002	Lower Chilkat	254,324	385	40771	Fall	No
2005	2001	Lower Chilkat	254,325	580	40553	Fall	No
2005	2002	Lower Chilkat	254,327	325	40771	Fall	No
2005	2002	Lower Chilkat	254,329	340	40771	Fall	No
2005	2002	Lower Chilkat	254,330	325	40771	Fall	No
2005	2002	Kelsall	264,014	405	40964	Spring	Yes
2005	2001	Kelsall	264,020	470	40553	Fall	No
2005	2001	Kelsall	264,079	700	40453	Spring	Yes
2005	2002	Kelsall	264,081	355	40964	Spring	Yes
2005	2001	Tahini	221,457	520	40553	Fall	No
2005	2001	Tahini	221,458	535	40553	Fall	No
2005	2002	Tahini	221,459	390	40771	Fall	No
2005	2001	Tahini	254,169	590	40553	Fall	No
2005	2002	Tahini	254,170	400	40771	Fall	No
2005	2001	Tahini	264,053	540	40553	Fall	No
2005	2001	Tahini	264,067	510	40553	Fall	No
2005	2001	Tahini	264,068	620	40453	Spring	Yes
2005	2001	Tahini	264,070	540	40553	Fall	No
2005	2001	Tahini	264,071	580	40553	Fall	No
2005	2002	Tahini	264,077	400	40771	Fall	No
2006	2003	Lower Chilkat	252,402	360	40962	Fall	No
2006	2003	Lower Chilkat	252,404	390	41136	Spring	Yes
2006	2003	Lower Chilkat	252,406	325	41028	Fall	No
2006	2003	Lower Chilkat	252,408	375	41136	Spring	Yes
2006	2001	Kelsall	254,239	830	40553	Fall	No
2006	2001	Kelsall	254,240	745	40553	Fall	No
2006	2001	Kelsall	254,243	840	40553	Fall	No
2006	2001	Kelsall	254,244	855	40553	Fall	No

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Calendar year	Brood year	Site	Head number	Length (mm MEF)	Tag code	Season tagged	Second CWT present
2006	2003	Kelsall	254,246	405	41028	Fall	No
2006	2001	Kelsall	254,247	845	40553	Fall	No
2006	2001	Kelsall	254,248	775	40553	Fall	No
2006	2001	Kelsall	254,359	825	40553	Fall	No
2006	2002	Kelsall	254,360	510	40771	Fall	No
2006	2001	Kelsall	254,362	800	40553	Fall	No
2006	2001	Kelsall	254,363	745	40553	Fall	No
2006	2001	Kelsall	254,364	730	40553	Fall	No
2006	2001	Kelsall	254,365	770	40553	Fall	No
2006	2002	Klehini	221,480	545	40964	Spring	Yes
2006	2003	Klehini	254,231	390	41136	Spring	Yes
2006	2001	Klehini	254,233	765	40553	Fall	No
2006	2001	Klehini	254,238	795	40453	Spring	Yes
2006	2001	Tahini	254,181	790	40553	Fall	No
2006	2001	Tahini	254,182	660	40453	Spring	Yes
2006	2001	Tahini	254,184	795	40553	Fall	No
2006	2002	Tahini	254,185	565	40771	Fall	No
2006	2003	Tahini	254,187	400	41136	Spring	Yes
2006	2001	Tahini	254,230	795	40453	Spring	Yes
2006	2003	Tahini	254,371	415	40962	Fall	No
2006	2001	Tahini	254,372	850	40553	Fall	No
2006	2002	Tahini	254,373	535	40771	Fall	No
2006	2003	Tahini	254,374	435	40962	Fall	No
2006	2003	Tahini	254,375	435	41028	Fall	No
2006	2003	Tahini	254,376	360	41028	Fall	No
2006	2003	Tahini	254,377	375	41028	Fall	No
2006	2002	Tahini	254,378	530	40771	Fall	No
2007	2004	Lower Chilkat	252,479	320	41302	Spring	Yes
2007	2004	Lower Chilkat	252,480	410	41219	Fall	Yes[a]
2007	2003	Lower Chilkat	252,481	515	41028	Fall	Yes[a]
2007	2003	Lower Chilkat	252,482	510	41028	Fall	No
2007	2004	Lower Chilkat	252,483	400	41219	Fall	No
2007	2004	Lower Chilkat	252,484	310	41219	Fall	No
2007	2004	Lower Chilkat	252,485	330	41302	Spring	Yes
2007	2004	Lower Chilkat	252,487	350	41302	Spring	Yes
2007	2004	Lower Chilkat	252,488	320	41219	Fall	No
2007	2004	Lower Chilkat	252,489	300	41219	Fall	No
2007	2004	Lower Chilkat	252,490	285	41219	Fall	No
2007	2004	Lower Chilkat	252,491	365	41219	Fall	No

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Calendar year	Brood year	Site	Head number	Length (mm MEF)	Tag code	Season tagged	Second CWT present
2007	2004	Kelsall	56,676	385	41302	Spring	Yes
2007	2004	Kelsall	56,677	360	41302	Spring	Yes
2007	2002	Kelsall	56,678	815	40812	Fall	No
2007	2002	Kelsall	254,107	760	40771	Fall	No
2007	2002	Kelsall	254,108	810	40771	Fall	No
2007	2003	Klehini	60,891	615	41136	Spring	Yes
2007	2003	Klehini	60,892	625	41136	Spring	Yes
2007	2003	Klehini	60,893	530	41136	Spring	Yes
2007	2003	Tahini	56,652	490	41028	Fall	No
2007	2003	Tahini	56,653	595	41028	Fall	No
2007	2003	Tahini	56,654	500	41028	Fall	No
2007	2001	Tahini	56,655	890	40453	Spring	Yes
2007	2003	Tahini	56,656	615	41028	Fall	No
2007	2003	Tahini	56,657	560	41028	Fall	No
2007	2003	Tahini	56,658	595	41136	Spring	Yes
2007	2003	Tahini	56,659	560	41028	Fall	No
2007	2003	Tahini	56,660	590	41028	Fall	No
2007	2002	Tahini	56,661	720	40964	Spring	Yes
2008	2004	Lower Chilkat	321,801	610	41302	Spring	Yes
2008	2005	Lower Chilkat	321,802	315	41398	Fall	No
2008	2004	Lower Chilkat	321,803	550	41302	Spring	Yes
2008	2005	Lower Chilkat	321,804	370	41398	Fall	No
2008	2005	Lower Chilkat	321,806	340	41398	Fall	No
2008	2005	Lower Chilkat	321,807	400	41398	Fall	No
2008	2004	Kelsall	53,735	610	41215	Fall	No
2008	2003	Kelsall	56,734	600	41028	Fall	No
2008	2004	Kelsall	56,736	615	41219	Fall	No
2008	2002	Kelsall	56,737	895	40812	Fall	No
2008	2002	Kelsall	56,738	890	40771	Fall	No
2008	2003	Kelsall	56,739	840	41028	Fall	No
2008	2004	Kelsall	56,740	530	41302	Spring	Yes
2008	2002	Klehini	60,896	850	40964	Spring	Yes
2008	2004	Klehini	60,976	450	41302	Spring	Yes
2008	2004	Klehini	60,977	610	41302	Spring	Yes
2008	2004	Klehini	60,978	535	41302	Spring	Yes
2008	2004	Tahini	56,680	630	41302	Spring	Yes
2008	2005	Tahini	56,681	380	41398	Fall	No
2008	2004	Tahini	56,682	540	41302	Spring	Yes
2008	2004	Tahini	56,683	575	41219	Fall	Yes[a]
2008	2003	Tahini	56,684	760	41028	Fall	No

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Calendar year	Brood year	Site	Head number	Length (mm MEF)	Tag code	Season tagged	Second CWT present
2008	2003	Tahini	56,685	725	41028	Fall	No
2008	2005	Tahini	56,686	295	41398	Fall	No
2008	2003	Tahini	56,687	585	41028	Fall	No
2008	2004	Tahini	56,688	520	41219	Fall	No
2008	2003	Tahini	56,689	740	41028	Fall	No
2008	2003	Tahini	56,690	680	41028	Fall	No
2008	2003	Tahini	56,691	765	41028	Fall	No
2009	2005	Lower Chilkat	343,071	510	41398	Fall	Yes[a]
2009	2005	Lower Chilkat	343,072	435	41398	Fall	No
2009	2005	Lower Chilkat	343,073	560	41398	Fall	No
2009	2005	Lower Chilkat	343,074	550	41398	Fall	No
2009	2005	Lower Chilkat	343,075	440	41398	Fall	No
2009	2006	Lower Chilkat	343,077	280	41557	Fall	No
2009	2006	Lower Chilkat	343,078	350	41557	Fall	No
2009	2006	Lower Chilkat	343,079	335	41557	Fall	No
2009	2006	Lower Chilkat	343,080	300	41557	Fall	No
2009	2004	Lower Chilkat	343,081	770	41219	Fall	No
2009	2005	Kelsall	343,027	480	41398	Fall	No
2009	2003	Kelsall	343,101	890	41028	Fall	No
2009	2005	Kelsall	343,102	560	41398	Fall	No
2009	2003	Klehini	343,062	830	41136	Spring	Yes
2009	2005	Klehini	343,063	420	41398	Fall	No
2009	2004	Klehini	343,064	720	41302	Spring	Yes
2009	2003	Klehini	343,065	860	41136	Spring	Yes
2009	2005	Klehini	343,090	415	41398	Spring	Yes
2009	2005	Tahini	343,028	635	41398	Fall	No
2009	2003	Tahini	343,029	835	41028	Fall	No
2009	2004	Tahini	343,030	815	41219	Fall	No
2009	2003	Tahini	343,031	965	41028	Fall	No
2009	2003	Tahini	343,032	930	41028	Fall	No
2009	2004	Tahini	343,033	790	41219	Fall	No
2009	2003	Tahini	343,034	950	41028	Fall	No
2009	2005	Tahini	343,035	520	41398	Fall	No
2009	2004	Tahini	343,036	770	41219	Fall	No
2009	2005	Tahini	343,037	640	41398	Spring	Yes
2009	2004	Tahini	343,038	820	41302	Spring	Yes
2009	2004	Tahini	343,039	760	41215	Fall	No
2009	2003	Tahini	343,040	880	40962	Fall	Yes[a]
2009	2003	Tahini	343,041	920	41028	Fall	No
2009	2005	Tahini	343,047	525	41398	Fall	No

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Calendar year	Brood year	Site	Head number	Length (mm MEF)	Tag code	Season tagged	Second CWT present
2009	2004	Tahini	343,048	755	41219	Fall	No
2009	2003	Tahini	343,049	810	41136	Spring	Yes
2009	2003	Tahini	343,050	880	41028	Fall	No
2009	2003	Tahini	343,051	900	41136	Spring	Yes
2009	2004	Tahini	343,052	880	41302	Spring	Yes
2009	2003	Tahini	343,053	920	41028	Fall	No
2009	2004	Tahini	343,054	810	41219	Fall	No
2009	2004	Tahini	343,055	685	41219	Fall	No
2009	2003	Tahini	343,056	885	41028	Fall	No
2009	2004	Tahini	343,057	790	41219	Fall	No
2009	2003	Tahini	343,058	795	41028	Fall	No
2009	2003	Tahini	343,059	980	41028	Fall	No
2009	2005	Tahini	343,060	640	41398	Fall	No
2009	2003	Tahini	343,103	940	41136	Spring	No[a]
2009	2003	Tahini	343,104	930	41028	Fall	No
2009	2003	Tahini	343,105	890	41028	Fall	No
2009	2004	Tahini	343,106	865	41219	Fall	No
2009	2003	Tahini	343,107	950	41028	Fall	No
2010	2007	Lower Chilkat	88,651	435	41510	Spring	Yes
2010	2004	Kelsall	88,701	880	41219	Fall	No
2010	2007	Kelsall	88,702	375	41510	Spring	No[a]
2010	2004	Kelsall	88,703	855	41219	Fall	No
2010	2007	Kelsall	88,757	430	41687	Fall	Yes[a]
2010	2007	Klehini	88,751	410	41510	Spring	Yes
2010	2006	Klehini	88,753	575	41292	Spring	Yes
2010	2007	Klehini	88,754	375	41687	Fall	No
2010	2004	Klehini	88,755	940	41219	Fall	Yes[a]
2010	2006	Klehini	88,756	460	41557	Fall	No
2010	2006	Tahini	88,721	520	41557	Fall	No
2010	2004	Tahini	88,722	900	41302	Spring	No[a]
2010	2006	Tahini	88,723	590	41557	Fall	No
2010	2006	Tahini	88,724	520	41557	Fall	No
2010	2004	Tahini	88,725	830	41219	Fall	No
2010	2004	Tahini	88,726	755	41219	Fall	No
2010	2005	Tahini	88,727	745	41398	Fall	No
2010	2005	Tahini	88,728	850	41398	Fall	No
2010	2005	Tahini	88,729	715	41398	Fall	No
2010	2004	Tahini	88,730	945	41219	Fall	No
2010	2006	Tahini	88,731	520	41557	Fall	No
2010	2005	Tahini	88,732	740	41398	Fall	No

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Calendar year	Brood year	Site	Head number	Length (mm MEF)	Tag code	Season tagged	Second CWT present
2010	2004	Tahini	88,733	920	41219	Fall	No
2010	2005	Tahini	88,734	760	41398	Fall	No
2010	2005	Tahini	88,735	745	41398	Fall	No
2010	2004	Tahini	88,736	890	41219	Fall	No
2010	2006	Tahini	88,737	480	41557	Fall	No
2010	2005	Tahini	88,738	780	41398	Fall	No
2010	2004	Tahini	88,739	890	41219	Fall	No
2010	2004	Tahini	88,740	910	41302	Spring	Yes
2010	2004	Tahini	88,741	900	41219	Fall	Yes[a]
2011	2007	Lower Chilkat	56,783	620	41687	Fall	No
2011	2008	Lower Chilkat	56,784	375	41789	Fall	No
2011	2008	Lower Chilkat	56,785	370	41789	Fall	No
2011	2007	Lower Chilkat	56,786	550	41687	Fall	No
2011	2007	Lower Chilkat	56,787	520	41510	Spring	No[a]
2011	2007	Lower Chilkat	56,788	555	41510	Spring	Yes
2011	2006	Lower Chilkat	56,789	680	41292	Spring	Yes
2011	2007	Lower Chilkat	56,790	635	41687	Fall	Yes[a]
2011	2007	Lower Chilkat	56,791	565	41510	Spring	Yes
2011	2007	Lower Chilkat	88,697	600	41510	Spring	Yes
2011	2007	Lower Chilkat	88,698	565	41687	Fall	No
2011	2007	Lower Chilkat	88,699	575	41687	Fall	No
2011	2005	Lower Chilkat	88,700	640	41398	Fall	No
2011	2005	Kelsall	88,798	810	41398	Fall	No
2011	2005	Kelsall	88,799	900	41398	Spring	Yes
2011	2004	Kelsall	88,800	840	41219	Fall	No
2011	2006	Kelsall	88,801	800	41557	Fall	No
2011	2006	Kelsall	88,802	750	41292	Spring	Yes
2011	2005	Kelsall	88,803	910	41398	Fall	No
2011	2006	Kelsall	88,805	810	41557	Fall	No
2011	2006	Kelsall	88,806	805	41557	Fall	No
2011	2005	Kelsall	88,807	585	41398	Fall	No
2011	2006	Kelsall	88,808	780	41557	Fall	No
2011	2005	Kelsall	88,809	920	41398	Fall	No
2011	2007	Klehini	88,786	470	41510	Spring	Yes
2011	2006	Klehini	88,787	560	41557	Fall	No
2011	2007	Tahini	88,614	590	41687	Fall	No
2011	2007	Tahini	88,615	590	41510	Spring	Yes
2011	2007	Tahini	88,616	465	41687	Fall	No
2011	2007	Tahini	88,617	600	41510	Spring	Yes
2011	2007	Tahini	88,618	600	41687	Fall	No

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Calendar year	Brood year	Site	Head number	Length (mm MEF)	Tag code	Season tagged	Second CWT present
2011	2007	Tahini	88,619	620	41687	Fall	No
2011	2005	Tahini	88,620	920	41398	Fall	Yes[a]
2011	2005	Tahini	88,742	835	41398	Fall	No
2011	2006	Tahini	532,151	815	41557	Fall	No
2011	2007	Tahini	532,152	640	41687	Fall	No
2011	2006	Tahini	532,153	850	41557	Fall	No
2011	2005	Tahini	532,154	860	41398	Fall	No
2011	2007	Tahini	532,155	645	41687	Fall	No
2011	2007	Tahini	532,156	585	41687	Fall	No
2011	2007	Tahini	532,157	575	41687	Fall	No
2011	2005	Tahini	532,158	920	41398	Fall	No
2011	2006	Tahini	532,159	830	41557	Fall	No
2011	2005	Tahini	532,160	865	41398	Fall	No
2011	2005	Tahini	532,161	815	41398	Fall	No
2011	2007	Tahini	532,162	670	41687	Fall	No
2011	2007	Tahini	532,163	605	41687	Fall	No
2011	2005	Tahini	532,164	865	41398	Fall	Yes[a]
2011	2006	Tahini	532,165	695	41557	Fall	No
2011	2005	Tahini	532,166	815	41398	Fall	No
2011	2005	Tahini	532,167	855	41398	Spring	Yes
2011	2006	Tahini	532,168	780	41557	Fall	No
2011	2005	Tahini	532,169	910	41398	Spring	Yes
2012	2009	Lower Chilkat	56,636	370	42089	Spring	Yes
2012	2009	Lower Chilkat	56,637	430	42089	Spring	Yes
2012	2009	Lower Chilkat	56,638	335	41991	Fall	No
2012	2009	Lower Chilkat	56,640	370	42089	Spring	Yes
2012	2008	Lower Chilkat	544,901	420	41789	Fall	No
2012	2006	Kelsall	88,810	970	41507	Spring	No[a]
2012	2006	Kelsall	88,811	880	41292	Spring	Yes
2012	2006	Kelsall	88,812	900	41557	Fall	No
2012	2007	Kelsall	88,813	745	41510	Spring	Yes
2012	2007	Kelsall	88,814	665	41510	Spring	Yes
2012	2007	Kelsall	88,815	760	41510	Spring	No[a]
2012	2007	Klehini	88,626	610	41510	Spring	No[a]
2012	2007	Klehini	88,627	760	41510	Spring	Yes
2012	2007	Tahini	532,170	800	41687	Fall	No

[a] Indicates erroneous handheld wand scan detection results.

Appendix D3.–Handheld wand scan results from 84 adipose finclipped brood year 2004 Chilkat River Chinook salmon escapement samples, 2007–2011. The season tagged was verified by the tag code for 50 fish whose heads were taken, assigned a head number, and tags decoded by the CWT Lab.

Year	River	Gear	Fish number	Head number	Head CWT	Dorsal CWT	Season tagged	Comments
2007	Lower Chilkat	FW	2	252,479	Y	Y	Spring	
2007	Lower Chilkat	FW	4	252,480	Y	Y	Fall	False +
2007	Lower Chilkat	FW	28	252,483	Y	N	Fall	
2007	Lower Chilkat	FW	29	252,484	Y	N	Fall	
2007	Lower Chilkat	FW	41	252,485	Y	Y	Spring	
2007	Lower Chilkat	FW	51	252,486	N	N	Fall	NO TAG
2007	Lower Chilkat	FW	52	252,487	Y	Y	Spring	
2007	Lower Chilkat	FW	69	252,488	Y	N	Fall	
2007	Lower Chilkat	FW	89	252,489	Y	N	Fall	
2007	Lower Chilkat	FW	109	252,490	Y	N	Fall	
2007	Lower Chilkat	FW	112	252,491	Y	N	Fall	
2007	Lower Chilkat	FW	113	Released	Not wand scanned		Unknown	Not wand scanned
2007	Kelsall	C	93	56,676	Y	y	Spring	
2007	Kelsall	C	105	56,677	Y	y	Spring	
2008	Lower Chilkat	FW	22	321,801	Y	Y	Spring	
2008	Lower Chilkat	FW	65	321,803	Y	Y	Spring	
2008	Kelsall	GN	15	53,735	Y	N	Fall	
2008	Kelsall	GN	18	Released	Y	Y	Spring	
2008	Kelsall	C	131	56,736	Y	N	Fall	
2008	Kelsall	C	186	56,740	Y	Y	Spring	
2008	Big Boulder	S	21	60,976	Y	Y	Spring	
2008	Lit. Boulder	S	76	60,977	Y	Y	Spring	
2008	Lit. Boulder	DN	103	60,978	Y	Y	Spring	
2008	Tahini	GN	46	56,679	N	N	Fall	NO TAG
2008	Tahini	GN	48	56,680	Y	Y	Spring	
2008	Tahini	GN	63	Released	Y	N	Fall	
2008	Tahini	GN	84	56,682	Y	Y	Spring	
2008	Tahini	GN	89	Released	Y	N	Fall	
2008	Tahini	GN	100	56,683	Y	Y	Fall	False +
2008	Tahini	GN	206	56,688	Y	N	Fall	
2009	Lower Chilkat	GN	4	Released	Y	N	Fall	
2009	Lower Chilkat	GN	37	Released	Y	N	Fall	
2009	Lower Chilkat	GN	62	Released	N	N	Fall	
2009	Lower Chilkat	GN	84	Released	Y	N	Fall	
2009	Lower Chilkat	FW	9	Released	Y	Y	Spring	
2009	Lower Chilkat	FW	67	Released	N	N	Fall	
2009	Lower Chilkat	FW	76	Released	Y	N	Fall	
2009	Lower Chilkat	FW	160	Released	Y	N	Fall	
2009	Lower Chilkat	FW	178	Released	Y	N	Fall	
2009	Lower Chilkat	FW	226	343,081	N	N	Fall	

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Year	River	Gear	Fish number	Head number	Head CWT	Dorsal CWT	Season tagged	Comments
2009	Big Boulder	S	68	Released	Y	Y	Spring	
2009	Lit. Boulder	C	42	343,064	Y	Y	Spring	
2009	Tahini	GN	35	Released	Y	N	Fall	
2009	Tahini	S	131	Released	Y	N	Fall	
2009	Tahini	S	148	343,048	Y	N	Fall	
2009	Tahini	S	172	Released	Y	N	Fall	
2009	Tahini	S	219	Released	Y	Y	Spring	
2009	Tahini	C	251	343,030	Y	N	Fall	
2009	Tahini	C	273	343,033	Y	N	Fall	
2009	Tahini	C	311	343,036	Y	N	Fall	
2009	Tahini	C	345	343,038	Y	Y	Spring	
2009	Tahini	C	349	343,039	Y	N	Fall	
2009	Tahini	C	393	343,052	Y	Y	Spring	No scale age
2009	Tahini	C	402	343,054	Y	N	Fall	
2009	Tahini	C	420	343,055	Y	N	Fall	
2009	Tahini	C	453	343,057	Y	N	Fall	
2009	Tahini	C	496	343,061	Y	Y	Spring	NO TAG
2009	Tahini	C	525	343,106	Y	N	Fall	
2010	Lower Chilkat	GN	7	Released	Y	Y	Spring	
2010	Lower Chilkat	GN	22	Released	Y	N	Fall	
2010	Lower Chilkat	GN	45	Released	Y	Y	Spring	
2010	Lower Chilkat	GN	47	Released	Y	Y	Spring	
2010	Lower Chilkat	GN	87	Released	Y	Y	Spring	
2010	Lower Chilkat	GN	98	Released	Y	N	Fall	
2010	Lower Chilkat	GN	107	Released	Y	N	Fall	
2010	Lower Chilkat	FW	7	Released	Y	N	Fall	
2010	Lower Chilkat	FW	60	Released	Y	Y	Spring	
2010	Kelsall	C	4	88,701	Y	N	Fall	
2010	Kelsall	C	71	88,703	Y	N	Fall	No scale age
2010	Big Boulder	S	35	Released	Y	N	Fall	
2010	Big Boulder	S	38	88,755	Y	Y	Fall	False +
2010	Big Boulder	S	54	Released	Y	Y	Spring	
2010	Tahini	GN	9	Released	Y	N	Fall	
2010	Tahini	GN	21	Released	Y	N	Fall	
2010	Tahini	C	75	88,722	Y	N	Spring	False -
2010	Tahini	C	101	88,725	Y	N	Fall	
2010	Tahini	C	104	88,726	Y	N	Fall	No scale age
2010	Tahini	C	222	88,730	Y	N	Fall	
2010	Tahini	H	242	88,733	Y	N	Fall	
2010	Tahini	C	279	88,736	Y	N	Fall	
2010	Tahini	C	306	88,739	Y	N	Fall	
2010	Tahini	C	307	88,740	Y	Y	Spring	
2010	Tahini	C	310	88,741	Y	Y	Fall	False +
2011	Kelsall	GN	115	88,800	Y	N	Fall	No scale age

Note: Gear codes FW = fish wheel; C = carcass; GN = gillnet; S = snag; DN = dip net; H = hand capture.

APPENDIX E

Appendix E1.–WinBUGS code and results of Bayesian statistical analysis of brood year (BY) 2004 Chinook salmon juvenile abundance, using results of handheld wand scans for dorsal CWT presence/absence.

<u>prior distributions for root nodes underlined</u>
fixed constants in bold
deterministic relationships in plain text (these link the priors and the likelihoods, or calculate auxiliary quantities)
likelihood (sampling distribution of data) in italics

BY 2004 constants
adclips <- 80 **# adipose finclips found in Chilkat escapement**
heads <- 79 **# fish scanned with wand (this is actually not relevant here)**
valid.tags <- 79 **# tag event assigned by wand/age sampling or Tag Lab**

MODEL {
<u>falseneg~ dbeta(falsenegDorsal, correct.ID.Dorsal)</u> <u># false negative dorsal CWT detection rate in spring fish</u>
<u>falsepos~ dbeta(falseposDorsal, correct.ID.NoDorsal)</u> <u># false positive dorsal CWT detection rate in fall fish</u>
<u>N.parr ~ dnorm(0,1.0E-12)</u> <u># abundance of parr in fall 2005</u>
<u>phi.1 ~ dbeta(0.30,0.30)</u> <u># proportion of parr surviving until spring 2006</u>
<u>rho ~ dbeta(0.1,0.1)</u> <u># proportion of adipose finclipped fish for which tag event was assigned</u>
M.parr <- 34696 **# number of parr marked in fall 2005**
M.smolt <- 5075 **# number of smolts marked in spring 2006**
C <- sum(R.tags[]) **# number of fish inspected in Chilkat escapement for adipose finclips**
m<-17 **# number of all Chilkat CWTs recovered in marine fisheries**
N.smolt <- N.parr * phi.1 # abundance of smolt in spring 2006
q.fall <- M.parr / N.parr # fraction marked in fall 2005
q.spring <- M.smolt / N.smolt # fraction marked in spring 2006
pi[1] <- ((1+falsepos)*q.fall-falseneg*q.spring)*rho # adjusted fraction assigned to fall event
pi[2] <- ((1+falseneg)*q.spring-falsepos*q.fall)*rho # adjusted fraction assigned to spring event
pi[3] <- (q.fall + q.spring) * (1 - rho) # fraction of returning fish with adipose fin clip, but tag event not assigned
pi[4] <- 1 - pi[1] - pi[2] - pi[3] # fraction of returning fish with no adipose fin clip
R.tags[1:4] ~ dmulti(pi[],C) *# vector of returns by type is multinomially distributed*
pi.fall <- q.fall / (q.fall + q.spring) # fraction of fall tags among Chilkat CWTs in marine fisheries
m.fall ~ dbin(pi.fall,m) *# number of fall tags among Chilkat tags is binomially distributed*
}

DATA
list(falsenegDorsal=7, correct.ID.Dorsal=63,falseposDorsal=11,correct.ID.NoDorsal=182,
R.tags= c(48,31,1,645), m.fall=10)
# Data terms are:
# a.) Calendar year 2005-2012 Chilkat escapement sampling results: false negative (7) and correct (63).
# dorsal CWT present in spring fish, false positive (11) and correct (182) dorsal CWT absent in fall fish;
# b.) BY 2004 Chilkat escapement sampling results: 48 fish assigned fall, 31 fish assigned spring, 1 fish
# not assigned, 645 fish with intact adipose fins;
# c.) BY 2004 marine recoveries of Chilkat fall CWTs: 10.

INITS
list(N.parr = 506000, phi.1=0.2, rho=0.9, falseneg=0.10, falsepos=0.06)

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RESULTS

Node	Mean	SD	MC error	2.5%	10.0%	Median	90.0%	97.5%	Start	Sample
N.parr	529,700	70,150	333	410,500	444,900	523,600	621,500	684,300	4,001	396,000
N.smolt	122,800	19,820	35	88,950	98,510	120,000	148,100	166,500	4,001	396,000
falseneg	0.0991	0.0352	6.816E-5	0.0415	0.0569	0.0953	0.1461	0.1776	4,001	396,000
falsepos	0.0567	0.0166	2.894E-5	0.0288	0.0367	0.0552	0.0787	0.0933	4,001	396,000
phi.1	0.2338	0.0461	1.584E-4	0.1569	0.1789	0.2292	0.2946	0.3371	4,001	396,000
pi[1]	0.0653	0.0089	4.067E-5	0.0490	0.0542	0.0649	0.0769	0.0837	4,001	396,000
pi[2]	0.0425	0.0014	1.136E-5	0.0296	0.0336	0.0421	0.0519	0.0577	4,001	396,000
pi[3]	0.0015	0.0014	3.720E-6	5.113E-5	1.879E-4	0.0011	0.0034	0.0053	4,001	396,000
pi[4]	0.8907	0.0116	4.196E-5	0.8671	0.8756	0.8811	0.9053	0.9123	4,001	396,000
rho	0.9863	0.0129	3.337E-5	0.9522	0.9692	0.9900	0.9983	0.9995	4,001	396,000

Note: Wand scan error rates (falseneg and falsepos) from 2005–2012 Chilkat River Chinook salmon escapement sampling were used to adjust proportions of BY 2004 fish CWT tagged in fall 2005 and spring 2006.

Appendix E2.–Alternate WinBUGS code and results of Bayesian statistical analysis of brood year 2004 Chinook salmon juvenile abundance, using coded wire tag (CWT) data restricted to heads taken from sacrificed fish.

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prior distributions for root nodes underlined
fixed constants in bold
deterministic relationships in plain text (these link the priors and the likelihoods, or calculate auxiliary quantities)
likelihood (sampling distribution of data) in italics

```
BY 2004 constants
  adclips <- 80                     # fish with adipose fin clips found in Chilkat escapement
  heads <- 53                       # heads collected from adipose finclipped fish
  valid.tags <- 50                  # CWTs decoded by Tag Lab

Model {
  N.parr ~ dnorm(0,1.0E-12)         # abundance of parr in fall 2003
  phi.1 ~ dbeta(0.3,0.30)           # proportion of parr surviving until spring 2004
  rho ~ dbeta(0.1,0.1)              # proportion of adipose finclipped fish with decoded CWT
  M.parr <- 34696                   # parr marked
  M.smolt <- 5075                   # smolts marked
  C <- sum(R.tags[])                # fish inspected in Chilkat escapement for adipose fin clips
  m<-17                             # number of Chilkat CWTs recovered elsewhere, fall and spring
  N.smolt <- N.parr * phi.1         # abundance of smolt in spring
  q.fall <- M.parr / N.parr         # fraction tagged in fall
  q.spring <- M.smolt / N.smolt     # fraction tagged in spring
  pi[1] <- q.fall*rho               # fraction of return from which we expect a valid fall tag
  pi[2] <- q.spring*rho             # fraction of return from which we expect a valid spring tag
  pi[3] <- (q.fall + q.spring) * (1 - rho) # fraction of return with adipose fin clip, but tag not decoded
  pi[4] <- 1 - pi[1] - pi[2] - pi[3] # fraction of return with no adipose fin clip
  R.tags[1:4] ~ dmulti(pi[],C)      # vector of returns by type is multinomially distributed
  pi.fall <- q.fall / (q.fall + q.spring) # fraction of fall tags among all Chilkat CWTs in marine fisheries
  m.fall ~ dbin(pi.fall,m)          # number of fall tags among all Chilkat CWTs is binomially distributed
  }

DATA
list(R.tags=c(32,18,30,645),m.fall = 10) # Data terms are sampling results: 32 fall tags, 18 spring tags, 30 heads with
     # tags not decoded, and 645 fish with intact adipose fins in the escapement, 10 marine fishery recoveries.

INITS
list(N.parr =506000, phi.1=0.2, rho=0.6)
```

RESULTS

node	mean	sd	MC error	2.5%	10.0%	median	90.0%	97.5%	start	sample
N.parr	513,100	74,440	348	387,900	423,800	505,700	611,300	679,000	4,001	396,000
N.smolt	130,900	26,770	55	89,290	100,300	127,300	166,000	193,300	4,001	396,000
phi.1	0.2615	0.0702	2.6E-04	0.1535	0.1817	0.2516	0.3533	0.4253	4,001	396,000
pi[1]	0.0431	0.0072	2.9E-05	0.0302	0.0342	0.0427	0.0525	0.0583	4,001	396,000
pi[2]	0.0252	0.0054	1.0E-05	0.0158	0.0186	0.0248	0.0323	0.0368	4,001	396,000
pi[3]	0.0410	0.0073	1.6E-05	0.0279	0.0319	0.0406	0.0507	0.0566	4,001	396,000
pi[4]	0.8907	0.0116	3.8E-05	0.8670	0.8756	0.8911	0.9053	0.9124	4,001	396,000
rho	0.6248	0.0537	7.8E-05	0.5164	0.5550	0.6259	0.6930	0.7268	4,001	396,000

APPENDIX F

Appendix F1.–Summary of Chilkat Chinook salmon stock assessment parameters from coded wire tag studies, brood years 1988–1989, 1991, and 1999–2004.

PARAMETER ESTIMATES

Brood year (BY)	Large escape-ment[a]	Fall parr	Overwinter survival %	Smolt	Marked fraction, inriver	Harvest (≥age-1.1) Commercial	Sport	Subsistence	≥Age-1.2 Total harvest	Inriver return	Total return	Exploitation, %	Smolt to ≥age-1.2 survival %
1988[a]		ND	ND	ND	0.037	910	719	9	1,638	7,111	8,749	18.7	ND
1989[b]		ND	ND	ND	0.110	283	373	27	683	6,233	6,916	9.9	ND
1991[c]	5,883	ND	ND	ND	0.048	681	374	58	1,006	11,900	12,906	7.8	ND
1998[d]	3,657	ND	ND	123,680	0.015	191	849	ND	1,040	3,596	4,636	22.4	3.7
1999[e]	2,258	386,400	36.4	139,500	0.113	589	972	252	1,572	4,764	6,336	24.8	4.5
2000[f]	2,029	510,700	21.1	105,300	0.102	414	353	236	990	4,173	5,163	19.2	4.9
2001[g]	4,514	596,410	24.9	148,800	0.076	407	304	192	821	4,561	5,382	15.3	3.6
2002[h]	4,035	509,700	38.8	194,000	0.106	254	124	2	380	1,577	1,957	19.4	1.0
2003[i]	5,631	668,000	43.0	284,800	0.078	719	355	81	1,125	5,519	6,644	16.9	2.3
2004[j]	3,406	529,700	23.4	122,800	0.110	270	163	1	434	3,283	3,717	11.7	3.0
1999–2004	3,646	533,485	31.3	165,867	0.098	442	379	127	887	3,980	4,867	17.9	3.2

STANDARD ERRORS

Brood year (BY)	Large escape-ment	Fall parr	Overwinter survival %	Smolt	Marked fraction, inriver	Harvest (≥age-1.1) Commercial	Sport	Subsistence	≥Age-1.2 Total harvest	Inriver return	Total return	Exploitation, %	Smolt to ≥age-1.2 survival %
1988[a]		ND	ND	ND	0.009	235	327	1	403	789	885	NE	ND
1989[b]		ND	ND	ND	0.019	74	132	2	152	781	796	NE	ND
1991[c]	1,005	ND	ND	ND	0.008	176	124	2	210	1,167	1,186	NE	ND
1998[d]	565	ND	ND	30,554	NE	190	706	ND	731	488	879	12.5	1.2
1999[e]	408	38,020	6.5	21,920	0.009	108	550	78	541	562	780	6.7	0.9
2000[f]	334	74,290	4.8	17,170	0.010	107	161	86	211	681	713	4.2	1.0
2001[g]	721	87,540	10.1	49,770	0.002	130	126	139	222	727	760	4.1	1.3
2002[h]	433	81,390	10.6	47,020	0.015	77	52	0	93	234	252	4.5	0.2
2003[i]	690	75,490	8.3	49,870	0.008	118	116	60	226	657	695	3.3	0.5
2004[j]	456	70,150	4.6	19,820	0.012	91	67	0	112	435	449	3.0	0.6

Note: ND = no data.
[a] Data from Table 22.
[b] Data from Ericksen (1996).
[c] Data from Ericksen (1999).
Note: NE = not estimated.
[d] Data from Ericksen and Chapell (2006).
[e] Data from Chapell (2009).
[f] Data from Chapell (2010).
[g] Data from Chapell (2012).
[h] Data from Chapell (2013a).
[i] Data from Chapell (2013b).
[j] Data from Tables 16, 19, 22.

APPENDIX G

Appendix G1.–Computer data files used in the analysis of this report.

FILE NAME	DESCRIPTION
11FallChinookCWT.xls	Excel workbook containing trapping, length sampling, and sequential tag number data from BY 2010 Chinook salmon CWT project in fall 2011.
12SpringChinookCWT.xls	Excel workbook containing trapping, length and weight sampling data from BY 2011 Chinook salmon CWT project in spring 2012.
2011 Haines creel interview.dta	ASCII file containing edited angler interview data from the Haines marine sport fishery in 2011.
Haines Marine Creel 2011v3b.sas	SAS program to estimate effort and harvest in the 2011 Haines marine sport fishery using 2011 Haines creel interview.dta.
11KingsTagged.xls	Excel workbook containing raw data from Chinook salmon captured in the lower Chilkat River during 2011.
11KingSpawningSamples.xls	Excel workbook containing raw data from Chinook salmon sampled on the Chilkat River spawning tributaries during 2011.
11KingHainesSportSubsAWL.xls	Excel workbook containing raw data from Chinook salmon sampled in Haines marine sport and subsistence fisheries during 2011.